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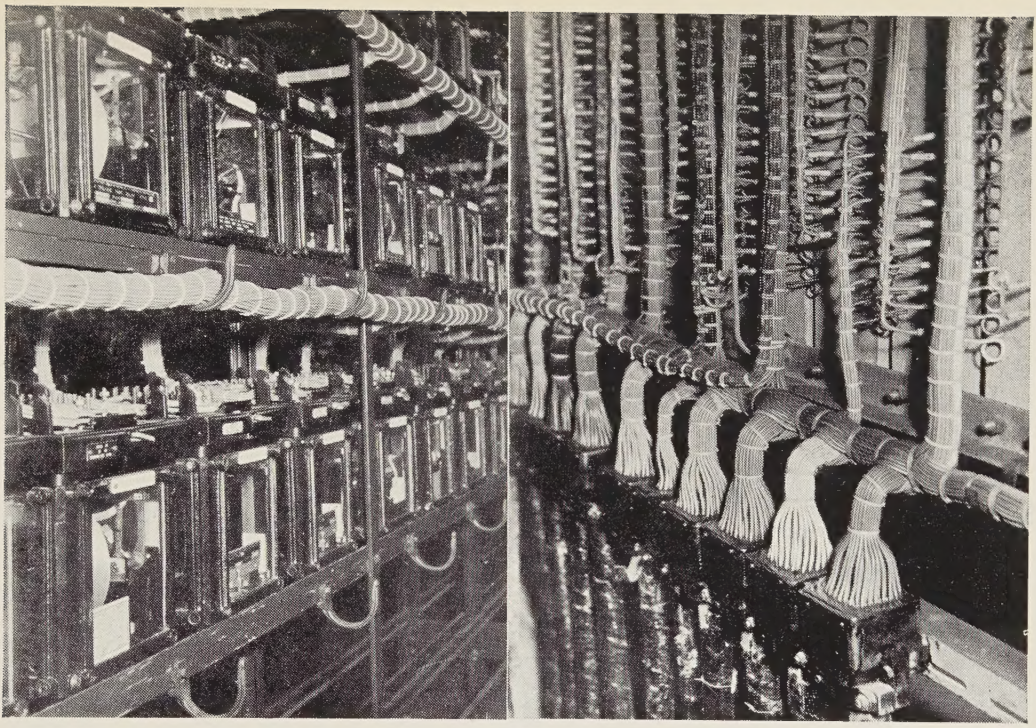
(English Edition)



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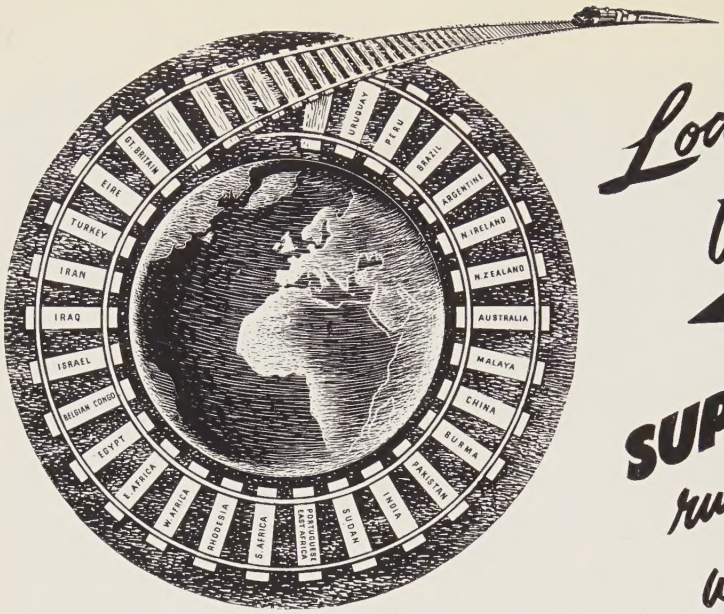

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An edition in French is also published.

Vol. XXVIII. — No. 4. April 1951.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[385. (06 .112]

FIFTEENTH SESSION

Rome : 25th September-4th October 1950.

GENERAL PROCEEDINGS

1st Section : WAY AND WORKS

INAUGURAL MEETING

September 26th, 1950, at 9 a. m.

PROVISIONAL CHAIRMAN : MR. R. CLAUDON,
MEMBER OF THE PERMANENT COMMISSION OF THE ASSOCIATION.

— The Meeting opened at 9 a.m.

The President (in French). — Gentlemen, the Permanent Commission of the Association requested me to preside over the inaugural meeting of the 1st Section and to make up its Bureau.

On behalf of the Permanent Commission, I suggest that Mr. JULIEN, Ingénieur en Chef des Ponts et Chaussées, Ingénieur en Chef des Transports chargé du contrôle des Installations fixes au Ministère des Travaux Publics et des Transports de France, be elected as *President*. Unfortunately, he will not be able to stay in Rome until the end of the Session; under these circumstances, I have agreed to assume the chairmanship after his departure. *(Applause.)*

As *Vice-Presidents*, I propose to appoint :

Mr. H. ROOS, Directeur Général des Chemins de fer de l'Etat de Finlande;

Mr. K.C. BAKHLE, Chief Commissioner of Railways to the Railway Board of India;

Mr. T.C. COURTNEY, Chairman of the Coras Iompair Eireann, member of the Permanent Commission of the Association;

Mr. C. LUCCHINI, Président de la Direction Générale des Chemins de fer fédéraux suisses, member of the Permanent Commission of the Association,

and as *Principal Secretary :*

Mr. J. DUBUS, Chief Engineer at the General Direction of the Belgian National Railways. *(Marks of approval and applause.)*

— The Section on the President's proposal subsequently completed its Bureau and drew up a provisional agenda.

QUESTION I.

Modern tendencies in the building of railway structures, especially bridges.

Results obtained in the construction of railway bridges in reinforced concrete.

Future prospects of the pre-stressed concrete.

Preliminary documents.

Report (America (North and South), Burma, China, Egypt, Great Britain and North Ireland, Dominions, Protectorates and Colonies, India, Iran, Iraq, Malay States and Pakistan), by A. DEAN. (See *Bulletin*, March 1950, p. 259 or separate issue No. 6.)

Report (Belgium and Colony, Denmark, France and Colonies, Luxemburg, Netherlands and Colonies, Norway, Poland, Switzerland and Syria), by L. MARGUERAT. (See *Bulletin*, August 1950, p. 1657 or separate issue No. 35.)

Report (Austria, Bulgaria, Czechoslovakia, Finland, Greece, Hungary, Italy, Portugal and Colonies, Rumania, Spain, Sweden, Turkey and Yugoslavia), by G. POLSONI. (See *Bulletin*, September 1950, p. 1887 or separate issue No. 38.)

Special Reporter : G. POLSONI (See *Bulletin*, October 1950, p. 2007.)

DISCUSSION BY THE SECTION.

Meeting held on the 26th September 1950.

MR. JULIEN ACTING AS PRESIDENT.

— The Meeting began at 9.15 a.m.

— The **President** (in French). — I will call upon Mr. DUBUS, *Principal Secretary*, to read the summaries of the special report (1).

(1) The English translation of the Summaries of Question I was amended as shown on pp. 13/14 of the *Daily Journal of the Session*, No. 1, dated 26th. September 1950.

Mr. Dubus. — *Summary 1 :*

1. *General.*

Present design requirements. Live load. Dynamic load, provision for fatigue.

Other than on American Railways, the live loadings now adopted are reasonably comparable and it is considered that a limit has now been reached.

Formulae laying down the dynamic loading, related solely to the span of a bridge

do not adequately cover all dynamic components. The effect of irregularities in the track, including the effect of rail joints, should be provided for.

Tests are desirable.

Special provision for fatigue effect is made when actual reversal of stress will occur.

It would be advisable to determine the effect of the eventual recovery of the structure of the metal for lower frequencies than those which have been considered up to the present in laboratory experiments.

The President (in French). — Is everyone in agreement about this summary, which is still rather controversial?

— *Summary 1 was adopted without alteration.*

Mr. Dubus. — *Summary 2 :*

2. *Metal Bridges.*

Decks entirely of metal construction are generally adopted when construction depth is limited. In such cases the track is generally carried on sleepers or cross ties, rail-bearers are usually fitted into the cross girders to give a shallow construction depth, bridging pieces being provided for continuity. The use of welding is still infrequent, but is being developed.

The use of reinforced concrete decks on metal bridges has been adopted widely in recent years, in conjunction with ballasted tracks, with the accompanying advantages.

Metal bridges are used for the bigger spans, for cases of limited construction depth and where provision must be made for settlement of foundations.

Plate girder construction is simpler and economical up to spans of 100-125 ft. For longer spans lattice girders of the simplest type are used.

Mild steel of about 24-27 tons/sq. inch ultimate is used widely. The use of special steel is only recommended in special cases. The use of light weight alloys has hitherto been limited to less important members.

Welding has been adopted for the construction of medium span plate girder bridges, with success up to the present. Only one case has been reported of the construction of a completely welded lattice girder bridge.

Combined steel and concrete construction, designed deliberately for composite action is a useful form which can be adopted with advantage for simple spans up to about 100-125 ft. Application to continuous girder construction involves prestressing the concrete deck at the intermediate piers.

The effect of shrinkage and the permanence of the bond between the two materials is not yet fully understood.

Mr. R. Lévi *(French National Railways)* (in French). — Regarding the use of cross ties preferably with rail-bearers, I do not want to suggest any alteration to the text, but I should like to point out that rail-bearers are of value in the case of straight sections of track. Perhaps it might be as well to point out that the use of cross ties is of value in particular on curves.

The President — Do you agree, Gentlemen, about the addition to Summary 2 suggested by Mr. R. Lévi?

Mr. Marguerat, *Reporter* (in French). — The point was raised in my report.

Mr. R. Lévi. — I do not wish to press the point, I merely wish to point it out.

The President. — We will take note of Mr. Lévi's remark.

Mr. R. Lévi. — As regards the fitting of the rail-bearers, I should point out that they are generally fitted into the cross members, not only to decrease the height, but also to facilitate fastening them directly to the cross members.

The President. — Are you suggesting an addition to the text?

Mr. R. Lévi. — I should like the second sentence of the first paragraph : « ... to decrease the height... » to be completed by the words « ... *and to facilitate direct fastening*, continuity, etc. ».

Mr. Marguerat. — I dot not entirely agree with Mr. R. LÉVI. Fitting the rail-bearers into the cross members makes it possible to decrease the height, but I do not think it simplifies the fastening. It is easier with rail-bearers which pass over the top of the cross member.

Mr. R. Lévi. — When the rail-bearer is fitted in, the housing is certainly less good.

Mr. Marguerat. — If the rail-bearer is carried over the top, there is perfect continuity.

Mr. R. Lévi. — That is true, but the housing is not satisfactory.

Mr. Marguerat. — But there is complete continuity.

Mr. R. Lévi. — With a continuous rail-bearer, certainly.

I have a suggestion to make to meet Mr. MARGUERAT and that is to revise the sentence to bring out the point that lowering the rail-bearer makes it possible to regulate the height whilst making possible a satisfactory fastening by means of a sole plate.

Would you agree to that?

Mr. Marguerat. — Yes, it is possible to obtain a satisfactory fastening, even in this case.

Mr. R. Lévi. — Yes.

The President. — Are you suggesting an addition to the text?

Mr. R. Lévi. — Would you agree to an addition like this, Mr. MARGUERAT? *(Agreed.)*

The President. — I suggest you agree the wording together at the end of the meeting. *(Agreed.)*

Mr. Renda, *Italian State Railways* (in French). — I am wondering if the word « widely » in paragraph 2 of this summary is not excessive.

The President. — In France, the use of a reinforced concrete deck on metal bridges has been greatly developed.

Mr. Renda. — Could we not simply say : « ... is developed »?

The President. — Omitting the word « *widely* »?

Mr. R. Lévi. — I agree.

The President. — Are there any other countries in which the use of reinforced concrete decks on metal bridges is as extensively used as in France?

Mr. Marguerat. — From the replies I received, this method is used above all in France.

The President. — So that M. Renda's objection stands.

Mr. R. Lévi. — I agree.

The President. — The word « *widely* » will therefore be deleted.

Mr. Renda. — In paragraph 3 mention is made of free height. Why say « free »? We are merely repeating ourselves, since in paragraph 1 it says « metal bridges are used... for cases of limited construction depth ».

Mr. Dubus. — What do you suggest Mr. Renda?

Mr. Renda. — « Metal bridges are advisable in the case of long spans ».

Mr. Bouciqué, *Belgian National Railways* (in French.) — In paragraph 2, I read : « The use of reinforced concrete deck on metal bridges has been adopted widely in recent years, in conjunction with ballasted tracks, with the accompanying advantages ». Might not this seem to imply that there are no other ways of obtaining continuity of the ballast?

The President. — I do not think it can be taken in this sense.

Mr. Bouciqué. — We might say : « ... makes it possible *to obtain economically* the continuity of the ballast... ».

The President. — There are other solutions, but this is one solution. It does not exclude other solutions.

In paragraph 3 we might say : « The metal bridge is *also* to be considered ».

No objections?

Mr. R. Lévi. — By adding the word *also* do we not seem to repeat what was said in paragraph 2?

The President. — No.

Mr. Marguerat. — I do not agree, as it is not the same thing. Paragraph 2 deals with reinforced concrete decks, and paragraph 3 with metal bridges.

The President. — Is the Section of the opinion that the word *also* should be added?

Mr. Renda. — I will not insist upon it.

The President. — The wording will therefore remain as it is.

Mr. R. Lévi. — The solution mentioned in the penultimate paragraph : « Combined steel and concrete construction... » has been used in the case of two bridges by the S. N. C. F. so that I should be sorry not to leave the statement as it stands, but in reality I think it is rather too affirmative, since it is merely question of a trial. I think we should say « ... is a solution *which might be* interesting ».

The President. — And « advantageous ».

Mr. R. Lévi. — It certainly is. I think the Special Reporter will agree that these trials should be followed up to determine how concrete stands up to the stresses. We are only at the beginning of such experiments.

Mr. Marguerat. — I quite agree with Mr. LÉVI's suggestion. The last replies received were a little reticent.

The President. — We might say : « ... is a solution which might be interesting and advantageous ».

Mr. Marguerat. — « ... which *might perhaps...* »

Mr. R. Lévi. — I therefore suggest adding at the end of the sentence : « *It would be useful to see how it stands up in service .*»

The President. — That makes it rather long !

Mr. R. Lévi. — Or : « ... *see if concrete continues sufficiently strong* »?

The President. — We might say : « *It would be useful to study the way concrete stands up* ».

Mr. R. Lévi. — It is above all a question of finding out if the concrete which plays an active part when the bridge is built, continues to take its share of the stresses.

The President. — I suggest we decide upon this wording at the end of the Meeting.

Mr. R. Lévi. — I agree.

The President. — Is summary 2 adopted with these reservations? *(Agreed.)*

— Taking into account the remarks made during the discussions and after having been revised at the end of the Meeting, the complete text of *Summary 2* approved by the Meeting was as follows :

2. *Metal bridges.*

« Decking entirely of metal is indicated when there is only restricted construction depth available. In such a case the track is usually carried on sleepers or cross ties, the stringers or rail bearers are usually fixed between the flanges of the cross girders, continuity being assured by bridging pieces; *the fixing can then be made in a way, at least as satisfactory as when the rail bearers are placed on top of the cross girders.* Welding of site connections is still rare, but tends to be developed.

« The use of reinforced concrete decks on metal bridges has been adopted in recent years, in conjunction with ballasted tracks, with the accompanying advantages.

« Metal bridges are used for the bigger spans, for cases of limited construction depth, and where provision must be made for settlement of foundations.

« Plate girder construction is simpler and economical up to spans of 100-125 ft. For longer spans lattice girders of the simplest type are used.

« Mild steel of about 24-27 tons per square inch ultimate is used widely. The use of special steel is only recommended in special cases. The use of light weight alloys has hitherto been limited to less important members.

« Welding has been adopted for the construction of medium span plate girder bridges, with success up to the present. Only one case has been reported of the construction of a completely welded lattice girder bridge.

« Combined steel and concrete construction designed deliberately for composite action is a solution *which might be* interesting and advantageous for simple spans up to about 100-125 ft. Application to continuous girder construction involves prestressing the concrete deck at the intermediate piers.

« *The first bridges of this type should be kept under observation to find out how the bond between the two materials was affected in the course of the time.* »

Mr. Dubus. — *Summary 3 :*

3. *Arch bridges built of concrete or stone.*

Such bridges are generally economical, particularly in maintenance, and are preferred whenever local conditions are suitable. Concrete is widely used and is the cheaper; construction in natural stone gives improved appearence, but is generally more costly; stone faced concrete is a suitable compromise provided steps are taken to obtain a reliable bond.

Weak concrete is generally used for the backing between spandril walls.

Pin type joints are not necessary unless the bearing of the foundations is in doubt.

There exists inadequate reliable information on the precise dynamic loading of masonry arches carrying rail traffic, but it is likely to be less than for metal bridges.

The President. — Has anyone anything to say?

— *Summary 3 was adopted without comment.*

Mr. Dubus. — *Summary 4 :*

4. *Underbridges comprising girders encased in concrete.*

This is a useful form of construction when construction depth is shallow and when line occupation facilities are limited.

It involves a somewhat extravagant use of steel.

The President. — Does everyone agree with this wording?

Mr. Marguerat. — I should like to add : « *It is necessary to provide adequate transversal reinforcement* ».

The President. — Do you agree about this amendement?

— *Summary 4 was adopted with this alteration.*

Mr. Dubus. — *Summary 5 :*

5. *Road bridges or over-bridges.*

It appears that the most usual type at the present time is the three span reinforced concrete bridge.

Some countries make use of pre-stressed concrete.

It is general practice to provide as few piers as is reasonably possible in the construction of over-bridges spanning station and yard layouts.

The President. — Does anyone wish to say anything about this summary?

— *Summary 5 was adopted without comment.*

Mr. Dubus. — *Summary 6 :*

6. *Piers and abutments.*

Mass concrete is most widely adopted for piers and abutments. Hollow construction is only considered for special cases and where the intensity of foundation loading must be kept unusually low. Reinforced concrete, or steel framed piers are adopted to reduce obstruction to visibility and where loading gauge clearance requirements restrict the possible thickness.

The President. — Does everyone agree to this wording?

— *Summary 6 was adopted without alteration.*

Mr. Dubus. — *Summary 7 :*

7. *Platform roofs.*

Both steel and reinforced concrete are used, the umbrella type roof being the most usual form of construction.

Glazing is provided in most countries to meet particular local natural lighting requirements.

Other than where extreme climatic conditions prevail, it is usual for design purposes to provide for either snow load, or wind load, whichever is the greater, but not for both to be active simultaneously.

Mr. R. Lévi. — The end of this sentence is not very appropriate in the case of France, where the climate is never very severe, and where the regulations lay down that the wind and snow loads should be added together.

The President. — I think the text might be altered.

Mr. Marguerat. — Do you add on the snow load in France? In the regulations, do you take into account a reduced depth of snow?

Mr. R. Lévi. — We add the loads together, but the limits are reduced.

Mr. Marguerat. — You only count a proportion?

Mr. R. Lévi. — Possibly, it only represents a proportion.

Mr. Marguerat. — Do you limit the load to 30 kg/m^2 (6 lbs. per sq. ft.)?

Mr. R. Lévi. — The permissible stresses represent the wind loading. It is lower when wind loading is not taken into account.

Mr. Marguerat. — It is very difficult to put into words.

The President. — I am on the Committee. The regulation is being elaborated, and I think we should not be too absolute in the text.

Mr. R. Lévi. — In view of the fact that Switzerland is a damp country where there is a lot of wind, we might say : « Except in the case of very severe climates, the determination of the sections required is made, *as a rule*, by taking into account either the snow or wind load, but not by adding them together ».

The President. — Do you agree?

— *Summary 7 was adopted with this amendment.*

Mr. Dubus. — *Summary 8 :*

8. *Testing of structures.*

Testing of structures covers the following fields :

1° to confirm the behaviour and capacity of a new structure before it is brought into use;

2° to determine the safe load capacity of old bridges;

3° to investigate special general problems such as shrinkage, creep, dynamic effects of live loads.

The President. — No remarks?

— *This text was adopted without remark.*

Mr. Dubus. — *Summary 9 :*

9. *Reinforced concrete underbridges.*

Reports indicate that simple reinforced concrete slabs are used up to spans ranging from 18 to 48 ft.

Lighter forms of construction, using T beams or hollow beams, have enabled longer reinforced concrete spans to be built; particularly in continuous construction and with variable moments of inertia.

For long span bridges, arch construction lends itself more effectively to the rational use of reinforced concrete.

Not only should high strength be aimed at, but the concrete should be as nearly waterproof as possible and there should be a minimum of shrinkage.

Care should be taken to provide reinforcement in all parts of the structure where tension stresses occur, even if these stresses have not been taken into account in the design.

Mr. Polsoni, *Special Reporter* (in French). — I think 15 m (49′ 2 1/2″) is excessive, and simple concrete slabs are too heavy. In my opinion 10 m (29′ 6 3/8″) is long enough.

Mr. Marguerat. — To answer the point raised, I would like to say that the limiting span depends upon economic questions. It may vary considerably from one country to another, which was why we stated in our summary : a maximum span of from 6 to 10 m, and in some countries, in certain cases, up to 15 m. In Belgium the limiting span is 15 m; in Switzerland it is 14 m, in Denmark it is 12.50 m and in France it is 11 m.

Mr. Orlandini, *Italian State Railway* (in French). — It is 4 m in Italy.

Mr. Marguerat. — These are questions of economics. It is impossible to give an exact figure, but it is necessary to give the limits recognised in the different countries.

The President. — If there are cases of 15 m spans, as there are in Belgium, it is necessary to take this fact into account and report that such a span is the maximum.

Mr. Bouciqué. — In Belgium, such a span is exceptional. I think there is only only one such bridge. In general, the maximum span is limited to 8 to 10 m.

Mr. Leduc, *French National Railways* (in French). — I think the text is correct, as it does not say « *should be* used » but « *is* used » which is a statement of fact. The wording might be disputed if it said « *should be* », and as it merely states « *it is* », it is correct.

The President. — Do you insist upon changing the wording? I think that if there are some 15 m spans, it is not true to state : « ... is used for maximum spans of 6 to 10 m ». Have you come across any bridges with such spans M. Marguerat?

Mr. Marguerat. — I have not come across any bridges with such a span, I was going on the replies I received.

Mr. Orlandini. — I think it would be truer to say : « Slab construction is used for maximum spans of 6 to 10 m, and *in certain cases up to 15 m* », to cover the statements just made.

The President. — Or : « ... *exceptionally for longer spans* and up to 15 m ».

Does everyone agree to altering the text in this way?

— The Section agreed to the following wording : « Slab construction is used up to maximum spans of 6 to 10 m (20-33 ft.)

and in certain cases for spans up to 15 m (48 ft.) ».

— *Summary 9 was adopted with this alteration to the first paragraph.*

Mr. Dubus. — *Summary 10 :*

10. *Pre-stressed concrete.*

Pre-stressed concrete construction has already been used on several railway systems, but as yet in only a few cases for underbridges of spans not greater than about 36 ft. carrying usual main line loading, and 60 ft. carrying meter gauge loading.

At present, pre-stressed concrete lends itself to mass production of similar units; it also enables shallower construction to be adopted than when using ordinary reinforced concrete. It is hoped that its use will also be accompanied by reduced maintenance.

Its field of application will be extended when higher working stresses in the steel and concrete can be adopted with confidence.

There is need for more information on certain technical details relating to the practice and application of pre-stressing of concrete.

The President. — Has anyone any remark to make or explanations to give in connection with this summary?

— *Summary 10 was adopted without comment.*

The President. — Gentlemen, it remains for me to thank the Special Reporter and the Reporters for the excellent reports they prepared, as well as those delegates who took part in our discussions.

***

MISCELLANEOUS.

Mr. R. Lévi. — Mr. President, I would like to ask you if, in view of the fact we still have some time left this morning, we could not have an exchange of opinions on some questions dealt with in the reports, and in particular the special report, which were not included in the summaries. I am sure such an exchange of opinions would be interesting. *(Agreed.)*

— The Meeting then dealt with the following points in turn :

Fixing of the rail bearers in the bridge girders.

Mr. R. Lévi. — I mentioned the fixing of the rail bearers in the bridge girders, and I have been struck by the fact that in the countries mentioned in Mr. DEAN's Report, the tendency is as a rule to lay the bearers above the girders, whilst in the countries covered by Mr. MARGUERAT's Report, the contrary is the case. Consequently it would be interesting to compare the two practices, to find out if difficulties have not occurred in the English countries in making the fastenings on the cross girders, such as we have experienced in France.

The President. — Has anyone any statement to make in connection with the point raised by Mr. Robert LÉVI?

Mr. Marguerat. — In the countries with which I was concerned, this problem is relatively simple in the sense that metal bridges are only used on very level sites where it is question of obtaining the greatest possible height. I do not know if the problem is different in other countries.

Mr. Sandeman, *British Railways (replacing* Mr. DEAN, *Reporter).* — On

British Railways, I have never seen railbearers on top of cross girders. In general, the depth of construction is so limited that the railbearers must be fitted into the webs of the cross girders.

The President. — Therefore the question is settled, as everyone acts alike.

Protective covering between concrete and framework.

Mr. R. Lévi. — I should like to ask another question, as we have amongst us a representative of the British Railways, who will know the facts.

I should like to know why the British Railways when using concrete decking, have arranged for the concrete slabs to have a bituminous layer between them and the metal framework? I think other countries might be interested in this question, if they have not thought of using this medium between the decking and the framework.

Mr. Sandeman. — The use of precast reinforced concrete arose from the war-time shortage of timber. I do not know if in these war-time works bituminous sheeting was put in. Recently in Scotland several bridges which had been destroyed by floods were reconstructed with precast reinforced concrete slabs laid on the top of longitudinal girders and layers of bituminous sheeting were laid over the top flanges before the slabs were placed in position. Each slab was fixed down by two hook-bolts passing through holes in the slab and catching on the undersides of the top flanges. These bridges have only been completed recently and, so far, no difficulty has been experienced.

The main reason for providing the bituminous sheeting was to avoid point contacts between concrete and steelwork, that is to say, to spread the pressure uniformly over the flanges of the girders

The President. — Thank you.

Mr. Dubus. — It is very similar to the use of lead sheets in the past !

Mr. R. Lévi. — I thank Mr. Sandeman for this interesting explanation. May I ask a few more questions which I think will also interest other members of the Section?

Encasing the under side of girders.

Mr. R. Lévi. — I should like to know if the British Railways and other railways who build bridges in which the girders are encased, have found an entirely satisfactory way of encasing the under side of such girders.

Personally, I am very much in favour of encasing the under sides of girders, but there is some difficulty in getting satisfactory adhesion. I would very much like to know if any railways have found an effective method.

Mr. Sandeman. — In Great Britain, current practice is to encase beams completely including the bottom flanges except at the bearings. This process is carried out at the contractor's yard and, to ensure a satisfactory covering of the lower flanges, the beams are turned upside down before the steel reinforcement is placed in position and the concrete is poured. This method is proving satisfactory.

I can, however, recall that in the case of some bridges constructed about 1910 trouble has been experienced with the reinforced concrete covering of the bottom flanges of girders.

Mr. R. Lévi. — Thank you.

Mr. Bouciqué. — Mr. President, in Belgium there are a great many bridges with encased girders. In the case of under bridges we found it was useless to encase the under side of the girders, but in the case of over bridges, when the train runs under the girder, we make use of prefabricated troughs. We use small troughs with a 2-3 cm (25/32"-1 3/16") edge and small 3 mm (1/8") straps; the trough is put under the bridge, the straps folded over and the concrete run into the framing. This system is completely satisfactory and makes it impossible for the concrete to break away. These prefabricated troughs are extremely compact.

Mr. Sandeman. — In Great Britain, this system is also used. Cast iron troughs are also used and the underside of the girder and the inside of the troughs are heavily coated with red lead paint before the troughs are bolted up using bolts made of special non-rusting steel.

The President. — We have not made any trials of this kind in France.

Mr. R. Lévi. — We have carried out adhesion tests with concrete encasing a trellis.

Mr. Marguerat. — The question raised by Mr. R. LÉVI is included in the questionnaire.

Mr. R. Lévi. — Yes.

Mr. Marguerat. — From the replies received from the Administrations, I found that the railways, who state they find the encasing on the under side satisfactory, provide for a thickness of at least 5 cm (2"), which reduces the height.

Determination of the tensile stresses.

Mr. R. Lévi. — I have only one other point to raise concerning reinforced concrete bridges.

According to Mr. POLSONI's Report, Sweden uses a formula to determine the tensile stresses in the concrete so as to lessen the effects of contraction and putting under load. I would like to know if there is any Swedish representative here, if this formula has proved satisfactory?

The President. — Is there any representative of the Swedish Railways who can supply any information on this point? (1).

Mr. Polsoni, *Special Reporter.* — I do not know if the Swedish formula relating to the stresses in the concrete of the slabs has given satisfaction. I simply reproduced their formula in my report.

Mr. R. Lévi. — It is easy enough to set out a formula, the whole point is to know if it is worth anything! Is it possible to affirm that it is so in this case?

(1) This information is given in the Note written by M. Ejnar LANDBERG published as *Appendix to the Discussion.* (See page 201 of this *Bulletin.*)

Mr. Polsoni. — This formula has been endorsed by the regulations.

The President. — Has anyone else anything to ask?

Mr. Marguerat. — For your information, I might state that in the case of the new Swiss standards now being prepared, we have made provision for comparative calculations in what we call the first stage of the calculations, i. e. with strained concrete, which must not exceed 40 to 50 kgr/cm^2 (569 to 711 lbs. per square inch), this being merely a recommendation in order to limit cracks.

Supports.

Mr. Marguerat. — I would like to ask Mr. R. Lévi a question. I found much of interest in the reply received from France, amongst others the special supports used for metal bridges.

The French reply mentioned supports for metal bridges which seem very light compared with those habitually used to date. Have they proved satisfactory?

Mr. R. Lévi. — These supports, which were the subject of some theoretical and experimental investigations, have been used for some years. They have proved satisfactory. If any railways would like the drawings, I can send them to them. They are very economical.

Mr. Marguerat. — What are they like?

Mr. R. Lévi. — The regulations adopted are exactly those required; there is no surplus material. It is necessary to allow for a certain concentration of the stresses which the Hertz formulae allow. These phenomena have been studied by means of the photoelastic method. We have got very good results, and have arrived at a solution which works, a very rare thing, and which is not expensive!

Tubular bridges.

Mr. Marguerat. — I have another question for Mr. R. Lévi. It is stated that in the case of reinforced concrete bridges, the S. N. C. F. went as far as a maximum span of 47 m (154′) for bridges with tubular sections, but afterwards went back to shorter spans. I should like to know the exact reason for this?

Mr. R. Lévi. — There is no mystery about it. The reasons which made us hesitate after the first examples to go on building such long spans are given in detail in the various reports : it was owing to the cracks which occurred in the concrete, which looked rather alarming to those who did not understand the matter. In actual fact, these cracks in the concrete were fairly well distributed so that there was no fear of large concentrations of very great stresses, but they did look rather alarming.

Mr. Marguerat. — Were they cracks due to the tensile stresses or to contraction, from oblique stresses?

Mr. R. Lévi. — Cracks due to both contraction and tensile stresses. After the war there was a lot of cement in France which contained an appreciable proportion of slag, slag which was not

perfectly controlled, which led to rather accentuated contraction, to such an extent that some structures cracked while still in the framing. Obviously, even if precautions are taken it is impossible to avoid a certain amount of contraction, which added to the stresses due to the actual load of the bridge, gives rise to the cracks which always occur with reinforced concrete.

Mr. Dubus. — May I ask if this applies to bridges with a maximum span up to 47 m, and of what type?

Mr. R. Lévi. — The bridges in question were tubular bridges with rectangular sections.

The use of protective coverings on prestressed concrete bridges.

Mr. Bouciqué. — Mr. President, I would like to ask a question. It is the rule in Belgium to use a protective covering on concrete bridges, often made of asphalt. Have any countries yet had sufficient experience of prestressed concrete bridges to decide whether such a covering is unnecessary? Is such a protective covering used in France?

Mr. R. Lévi. — In principle, it is never used.

The President. — Are there any countries with a wide experience of the use of prestressed concrete in bridges?

Mr. R. Lévi. — The British Railways.

Mr. Sandeman. — In Great Britain, no waterproof covering is provided so far as I know. I am not really « au fait » with the position, but, so far as I am aware, only a few prestressed concrete bridges have so far been constructed.

Mr. Marguerat. — I think I can tell Mr. BOUCIQUÉ that in my opinion the use of prestressed concrete does not greatly increase the watertightness.

Mr. R. Lévi. — Do you mean to say that the fact the concrete is prestressed prevents any cracks?

Mr. Marguerat. — It does not prevent the concrete itself not being watertight; if you have a porous type of concrete, whether it is prestressed or not, it will let the water in.

Mr. R. Lévi. — I would say in principle that we are not in favour of the so called elastic coverings on reinforced concrete bridges for the reason that if there are no cracks, the covering is useless, and if cracks occur, the covering will also break. In the case of prestressed concrete, there are no cracks.

Mr. Maguerat. — I quite agree with M. R. LÉVI, but this presupposes that the prestressed concrete is watertight.

Mr. R. Lévi. — It must be watertight, but I would add, to answer Mr. BOUCIQUÉ, that prestressed concrete is necessarily watertight because in order to make it, it is necessary to make good concrete.

Dynamic coefficients.

The President. — I would like to ask Mr. MARGUERAT a question. As regards

the dynamic coefficients, have you found that some countries have gone further than others?

Mr. Marguerat. — The same stage has been reached in nearly every country. I had to deal with; all the formulae are based solely on the length of the span. Only France is different and includes the actual weight. There are some coefficients which take certain corrections into account, for example the rail joints that have been suppressed, etc. In fact, the structure of the formula is the same everywhere, except in France.

The President. — Thank you.

Prestressed concrete railway bridges.

Mr. Marguerat. — I should like to ask the representative of the S. N. C. B. one more question. I was very astonished to see that there were no prestressed concrete railway bridges in Belgium. Is it true?

Mr. Bouciqué. — We have only built one experimental prestressed concrete bridge — which moreover is not yet in service — on the Nord-Midi Junction at Brussels. This railway bridge runs over a road.

We have built different types of bridges: one in ordinary reinforced concrete, the other in reinforced concrete with special reinforcement, and finally a prestressed concrete bridge as an experiment. Unfortunately, this bridge will not be in service till next year. The span is 15 m (49').

Mr. Marguerat. — Thank you.

The President. — Has anyone else anything to ask, or explanations to give?

— As no-one wished to speak, the Meeting ended at 10.45 a.m.

DISCUSSION AT THE PLENARY MEETING.

Meeting held on the 29th September 1950.

DR. ENG. DI RAIMONDO, PRESIDENT, IN THE CHAIR.
GENERAL SECRETARIES : MR. P. GHILAIN AND DR. ENG. M. VALDIVIESO.
ASSISTANT GENERAL SECRETARY : MR. CH. E. WHITWORTH.

The President (in French). — Gentlemen, our agenda to-day includes an examination of the Summaries adopted in the different Sections.

Will the General Secretary be good enough to submit to the Meeting the Summaries of Question I (Section I).

Mr. Ghilain, *General Secretary* (in French). — The text of the Summaries for Question I was published in the *Daily Journal of the Congress*, No. 2 of the 27th September.

(No objections were raised during the examination of these Summaries.)

The President. — We may therefore consider the Summaries for Question I as adopted.

SUMMARIES.

1. *General. Present design requirements. Live load. Dynamic load, provision for fatigue.*

« Other than on American Railways, « the live loadings now adopted are « reasonably comparable and it is con- « sidered that a limit has now been « reached.

« Formulae laying down the dynamic « loading, related solely to the span of « a bridge do not adequately cover all « dynamic components. The effect of « irregularities in the track, including « the effect of rail joints, should be « provided for.

« Tests are desirable.

« Special provision for fatigue effect « is made when actual reversal of stress « will occur.

« It would be advisable to determine « the effect of the eventual recovery of « the structure of the metal for slower « frequencies than those which have « been considered up to the present in « laboratory experiments.

2. *Metal bridges.*

« Decking entirely of metal is indi- « cated when there is only restricted « construction depth available. In such « a case the track is usually carried on « sleepers or cross ties, the stringers or « rail bearers are usually fixed between « the flanges of the cross girders, con- « tinuity being assured by bridging « pieces; the fixing can then be made « in a way, at least as satisfactory as « when the rail bearers are placed on « top of the cross girders. Welding of

« site connections is still rare, but tends « to be developed.

« The use of reinforced concrete « decks on metal bridges has been « adopted in recent years, in conjunc- « tion with ballasted tracks, with the « accompanying advantages.

« Metal bridges are used for the « bigger spans, for cases of limited con- « struction depth, and where provision « must be made for settlement of foun- « dations.

« Plate girder construction is simpler « and economical up to spans of 100- « 125 ft. For longer spans lattice « girders of the simplest type are used.

« Mild steel of about 24-27 tons per « sq. inch ultimate is used widely. The « use of special steel is only recom- « mended in special cases. The use of « light weight alloys has hitherto been « limited to less important members.

« Welding has been adopted for the « construction of medium span plate « girder bridges, with success up to the « present. Only one case has been « reported of the construction of a com- « pletely welded lattice girder bridge.

« Combined steel and concrete con- « struction designed deliberately for « composite action is a solution which « might be interesting and advantageous « for simple spans up to about 100- « 125 ft. Application to continuous « girder construction involves pre- « stressing the concrete deck at the inter- « mediate piers.

« The first bridges of this type should « be kept under observation to find out « how the bond between the two « materials was affected in the course « of the time.

3. *Arch bridges, built of concrete or stone.*

« Such bridges are generally eco- « nomical, particularly in maintenance « and are preferred whenever local con- « ditions are suitable. Concrete is « widely used and is the cheaper; con- « struction in natural stone gives im- « proved appearance, but is generally « more costly; stone faced concrete is « a suitable compromise provided steps « are taken to obtain a reliable bond.

« Weak concrete is generally used for « the backing between spandril walls.

« Pin type joints are not necessary « unless the bearing of the foundations « is in doubt.

« There exists inadequate reliable « information on the precise dynamic « loading of masonry arches carrying « rail traffic, but it is likely to be less « than for metal bridges.

4. *Underbridges comprising girders encased in concrete.*

« This is a useful form of construc- « tion when construction depth is « shallow and when line occupation « facilities are limited. It involves a « somewhat extravagant use of steel, « and it is necessary to provide ade- « quate transverse reinforcement.

5. *Road bridges or over-bridges.*

« It appears that the most usual type « at the present time is the three span « reinforced concrete bridge.

« Some countries make use of pre- « stressed concrete.

« It is general practice to provide as « few piers as is reasonably possible in « the construction of overbridges span- « ning station and yard layouts.

6. *Piers and abutments.*

« Mass concrete is most widely adopted for piers and abutments. Hollow construction is only considered for special cases and where the intensity of foundation loading must be kept unusually low. Reinforced concrete, or steel framed piers are adopted to reduce obstruction to visibility and where loading gauge clearance requirements restrict the possible thickness.

7. *Platform roofs.*

« Both steel and reinforced concrete are used, the umbrella type roof being the most usual form of construction.

« Glazing is provided in most countries to meet particular local natural lighting requirements.

« Except in the case of very severe climates, the determination of the sections required is made, as a rule, by taking into account either the snow or wind load, but not by adding them together.

8. *Testing of structures.*

« Testing of structures covers the following fields :

« 1° to confirm the behaviour and capacity of a new structure before it is brought into use;

« 2° to determine the safe load capacity of old bridges;

« 3° to investigate special general problems such as shrinkage, creep, dynamic effects of live loads, etc.

9. *Reinforced concrete underbridges.*

« Slab construction is used up to maximum spans of 20-33 ft. and in certain cases for spans up to 48 ft.

« Lighter forms of construction, using T beams or hollow beams, have enabled longer reinforced concrete spans to be built, particularly in continuous construction and with variable moments of inertia.

« For long span bridges, arch construction lends itself more effectively to the rational use of reinforced concrete.

« Not only should high strength be aimed at, but the concrete should be as nearly waterproof as possible and there should be a minimum of shrinkage.

« Care should be taken to provide reinforcement in all parts of the structure where tension stresses occur, even if these stresses have not been taken into account in the design.

10. *Pre-stressed concrete.*

« Pre-stressed concrete construction has already been used on several railway systems, but as yet, in only a few cases for underbridges of spans not greater than about 36 ft. carrying usual main line loading, and 60 ft. carrying meter gauge loading.

« At present, pre-stressed concrete lends itself to mass production of similar units, it also enables shallower construction to be adopted than when using ordinary reinforced concrete. It is hoped that its use will also be accompanied by reduced maintenance.

« Its field of application will be extended when higher working stresses in the steel and concrete can be adopted with confidence.

« There is need for more information on certain technical details relating to the practice and application of pre-stressing of concrete. »

Determination of the stresses and the width of cracks in reinforced concrete bridges, according to the Swedish method,

by M. Ejnar LANDBERG,

Engineer in the Bridges and Structures Department of the Royal Swedish State Railways, and Lecturer at the Royal Higher Polytechnical School at Stockholm.

In order to study the problem of cracks in reinforced concrete bridges, a series of trials and investigations was undertaken in 1943 by the Institute of Bridges and Structures at the Royal Higher Polytechnical School at Stockholm (= Broinstitutionen, Kungl. Tekniska Högskolan = K. T. H.) in collaboration with the Swedish Cement and Concrete Research Institute (= Cement och Betonginstitutet = C.B.I.) and the Royal Administration of Bridges and Highways (= Väg — och vattenbyggnadsstyrelsen = V. o. V.).

Measurements of the width and extent of cracks were carried out on trial T girders in the laboratory, and on seven reinforced concrete bridges in actual service, the oldest of which was ten years old. The laboratory investigations were divided into two separate studies : the influence of positive moments and that of negative moments. These trials were later followed by adhesion tests.

The results of the trials on small scale models in the case of positive moments and the extent of cracks on bridges were published in detail in Swedish in the review *Betong*, the medium of the Swedish Concrete Association, 1947, N° 2 (G. WÄSTLUND, P. O. JONSSON : « Undersökning rörande sprickbildning i armerade betongkonstruktioner », 49 pages, 12 tables, 52 figures, with an English summary). This study also was published in the C. B. I. review, 1947, No. 10 (*Cement och Betonginstitutets Handlingar*, 1947, No. 10). In the preliminary Publication of the IIIrd Congress of the International Bridges and Highways Association, held at Liège in 1946, an abridged report of the same study was published in English. This report also included some of the preliminary results of the trials of negative moments (G. WÄSTLUND, P. O. JONSSON : « Investigation on formation of cracks in reinforced concrete structure », 11 pages, 3 tables, 4 figures, with French and German summaries). This English report was also published in the C. B. I. Bulletins, 1948, No. 13 (*Cement och Betonginstitutets Bulletiner*, 1948, No. 13).

The two studies mention the publication of new trials and a theoretical study.

The State regulations, approved in 1942, stipulate in the case of bridges a relation between the allowable stress σ_{bd} and the limiting value of the stresses σ_b, according to the formula

$$\sigma_{bd} \leq 0.30\ \sigma_b + 20\ \text{kg/cm}^2 \qquad (\sigma_b \geq 50).$$

The application of this formula proved expensive in actual fact, as in many cases it necessitated a fairly large increase in the cross section of reinforced concrete bridges. However, in spite of this increase, cracks were still found which exceeded the allowable limits.

On the basis of the measurements made, MM. WÄSTLUND (C. B. I. and K. T. H.), P. O. JONSSON (K. T. H.) and J. OSTERMAN (V. o. V.) drew up a formula of a more or less empirical character based on the relation on the one hand between the cracks and on the other various characteristic qualities of the concrete and type of construction. As result of simplifications and certain theoretical comparisons, the following equation was obtained, as reported in our reply to the questionnaire :

$$T \geqslant \frac{m \cdot z \cdot \sqrt{d}}{W_b} \cdot \frac{E_a}{\sigma_a}$$

The formula gives a relative expression of the cracks : the greater the value of T, the smaller the width of the cracks. The object of applying this equation to the calculations is not to prevent cracks but to limit them to a certain width. It is therefore very important that T should be given a suitable and practical value.

The provisional regulations published in February 1947, by the Royal Administration of Bridges and Highways, fixed the way this formula should be applied to road bridges, in the cases quoted in our report. Certain values of T which were also given in our reply, had to be used. The Bridges and Structures Department of the Royal Swedish State Railways also found that in the case of State Railway bridges this same formula and the same values of T had to be used.

In December 1949 — i. e. after our report had been drawn up — new State regulations on concrete structures were issued (*Statliga betongbestammelser*, Del. 1. *Materialdelen.* S. O. U. 1949 : 64). In the case of bridges, the following applied :

Wherever, owing to climatic or other circumstances, serious cracking is not permitted, bridges must be built in such a way that the cracks will not attain considerable or dangerous widths. The more detailed form of construction will be laid down by the competent Departments.

As will be seen, the T formula mentioned in our report does not come into the new State regulations. The main reason for this is as follows :

1) During the investigation into cracks reported above, it was found that the T equation might have to be altered to a different form, attaching greater importance to certain qualities which were not sufficiently considered in the above expression.

2) It appears that the values of T, sanctioned in the above mentioned provisional regulations of 1947, were, at least in the case of road bridges, too high. They increase the present requirements concerning the largest width of crack allowed and lead to an increase in the cost which may perhaps not be essential to the satisfactory behaviour of the structure.

Whilst awaiting the result of the research work being carried out, the Royal Administration of Bridges and Highways drew up some new provisional regulations in May 1950 modifying those of 1947, relating to the calculation of cracks (*Kungl. Väg- och vattenbyggnadsstyrelsen :* 1950 *års provisoriska föreskrifter).* According to these, the same T formula must still be used. The traction stresses allowable in the concrete, σ_{bd}, are decreased. They are only 62 to 68 % of the maximum figures formerly imposed. The zone in which the T equation must be used was also modified. It includes a calculated stress of 1.0 to 2.5 times the permitted stress σ_{bd}. It should be noted however that according to the regulations of 1947, the reinforced section must be used in the calculation of $\sigma_{bd}\left(n = \frac{E_a}{E_b} = 15\right)$, but according to the 1950 regulations, it is only the concrete section, i. e. without the reinforcement bars. The minimum values of T, drawn up in 1947, have been reduced by half.

In view of the fact that in the case of railway bridges, the ratio between the dead weight and the live load is different from that on road bridges, the Bridges and Structures Department of the Royal Swedish State Railways has so far not made any modifications to its provisional regulations concerning the calculation of cracks in reinforced concrete railway bridges on the State Railways.

The above report shows that in Sweden, as far as bridges are concerned, a certain maximum value has been given to the stresses allowed. Instead an endeavour is being made to fix an allowable width for cracks.

The T formula used in the calculations must be taken as provisional. Certain modifications in the form of the expression must be expected when the present investigations have been completed. These will perhaps be published during the year 1951.

Stockholm, 24th November 1950.

QUESTION II.

Rail-joints : improvements in fishplated joints.
Use of long welded rails : optimum length in relation to the safety and good condition of the permanent way.
Expansion gaps. Determination of standard allowances.

Preliminary documents.

Report (Belgium and Colony, Denmark, France and Colonies, Luxemburg, Netherlands and Colonies, Norway, Poland, Switzerland and Syria), by O. LEDUC. (See *Bulletin*, February 1950, p. 127 or separate issue No. 2.)

Supplement to Report by O. LEDUC. (See *Bulletin*, September 1950, p. 2001.)

Report (Australia, Bulgaria, Czechoslovakia, Finland, Greece, Hungary, Italy, Portugal and Colonies, Rumania, Spain, Sweden, Turkey and Yugoslavia), by B. RENDA. (See *Bulletin*, March 1950, p. 167 or separate issue No. 3.)

Report (America (North and South), Burma, China, Egypt, Great Britain and North Ireland, Dominions, Protectorates and Colonies, India, Iran, Iraq, Malay States and Pakistan), by P. CROOM-JOHNSON. (See *Bulletin*, March 1950, p. 207 or separate issue.)

Special Reporter : O. LEDUC. (See *Bulletin*, October 1950, p. 2017.)

DISCUSSION BY THE SECTION.

Meeting held on September 27th, 1950.

MR. JULIEN IN THE CHAIR.

— The meeting opened at 9 a.m.

The President (in French). — Gentlemen, I call upon Mr. DUBUS, *Principal Secretary*, to read the Summaries of the Special report.

Mr. Dubus (in French). — We will begin by the examination of the Summaries relating to the *First Part : Fishplated rail joints.*

Summary No. 1 :

1. It is apparent from a study of the reports received that there has been no considerable modification to the traditional fishplated joint, which consists of two fishplates, short or long, strengthened to varying degrees by lower or upper ribs, and held in

place by bolts through the web of the rail. Complicated arrangements to provide a continuous running surface to the rail at the joint are not found in use to give the advantages hoped for by their inventors. Slant cutting of the rail ends is not favoured in current practice.

The President. — Gentlemen, are you agreed to adopt this wording?

— *Adopted without comment.*

Mr. Dubus. — *Summary 2 :*

2. To avoid excessive fatigue in the constituent parts of the joint, it is usual to reduce the sleeper spacing adjacent to rail ends. The most general practice is to support the rail on two independent sleepers closely spaced, in preference to a double sleeper. As to the joint supported on a single sleeper, this now seems to be falling into disuse except in the United States where, from information received, it is still widely practised.

The President. — Has anyone anything to say?

Mr. Bakhle, *Railway Board, India, and Vice-President.* — I think the last part of this paragraph might be slightly amended, because we in India are using a joint sleeper of cast iron and using it quite successfully on a metal sleeper bed. It is found that it is giving very good results in supporting the joint, and therefore the second sentence might be suitably amended. It says here : « The most general practise is to support the rail on two independent sleepers... ». I presume it refers to timber sleepers in the main, but where metal sleepers are used we find that the jointed sleeper supporting the joint is of very greet value.

Mr. Leduc, *Special Reporter* (in French). — I noted this special arrangement in Mr. CROOM-JOHNSON's report, but I thought it was merely a question of trials being carried out on certain sections in India, and that this method was far from being in general use, so that no definite conclusions could be drawn.

Mr. Bakhle. — Actually tests have been going on for some time now, and we are almost satisfied, and I would suggest therefore that the sentence should read as follows : « The most general practice is to support the rail on two independent sleepers closely spaced, where timber sleepers are used ». Then the third sentence might be slightly amended, as joints supported on a single sleeper are still used in the U. S. A. *and India.*

The President. — No objections to this addition?

Mr. Campbell, *British Railways.* — With regard to the second sentence and the reference to the two independent sleepers. It is essential that these two independent sleepers should be efficiently packed. I would therefore stress that the following words should be added : « two independent sleepers, closely spaced, *but sufficient to permit adequate packing...* ».

Mr. Dubus. — I suppose there are no objections to this addition?

The President. — Are you agreed, Gentlemen?

— *Summary 2 was adopted in the amended form given below to take*

MM. Bakhle *and* Campbell's *remarks into account :*

« 2. To avoid excessive fatigue in the constituent parts of the joint it is usual to reduce the sleeper spacing adjacent to rail ends. The most general practice is to support the rail on two independent sleepers, closely spaced, to allow of adequate packing in preference to a double sleeper. As to the joint supported on a single sleeper, this now seems to be falling into disuse, except in the U. S. A. and in India, where from information received it is still widely practised. »

Mr. Dubus. — *Summary No. 3 :*

3. The most general arrangement is for joints to be opposite each other. Whilst the use of joints out of square or staggered by half a rail length continues to be employed in some instances on sharp curves to assist in the maintenance of alignment, the use of staggered joints elsewhere which was once fairly frequent practice has gradually fallen into disfavour, probably because of the swing which they induce in rolling stock on tracks where the rail length is comparatively short. On modern track, however, with longer rails it would seem that better results can be obtained from the use of staggered joints, and it would be of interest, therefore, to renew experiments in this direction.

The President. — Has anyone any remark to make?

Mr. Campbell. — With regard to the reference to « swing », I suggest that probably in the translation the English might be improved by using the word « rolling ». As regards an improvement in rolling, it is suggested in the conclusion this might be effected by longer rails. I do suggest that the question of rolling is not dependent on the length of rail, but on the efficiency of the packing under the joint. I would therefore suggest the words towards the end of the conclusion be amended as follows : « ... on modern track, however, with longer rails and *more efficient methods of packing*, it would be of interest to experiment further to see if improved results can be obtained ».

Mr. Bakhle. — Mr. President, I notice that no reference has been made to the introduction of the short stagger. The reference is to the mid-stagger, or half a rail length. In the answers to the questionnaire which were sent from India it was mentioned that we were experimenting with the short stagger and subsequent to the submission of our answers to the questionnaire we have progressed a little bit further and we find that the introduction of the short stagger is a definite improvement. I would like with your permission to suggest an amendment in the last sentence. I would like to substitute in place of the last sentence :

« As, however, it would seem that better results can be obtained from the use of staggered joints it would be of interest to try out short staggering, equal to half the wheel base of a bogie truck, and with longer rails renew the experiment also with short and mid-stagger. »

This is the amendment I would like to propose.

Lt. Col. Wilson, *Ministry of Transport, Great Britain.* — I think that when one is talking of « swing » or « rolling », one wants to be a little more precise. Rolling in a vertical plane is distinct from the side thrust or lurching which takes place

in the horizontal plane, though the two movements are often combined. I would suggest, therefore, that in paragraph 3 of the Summary, one should say « probably because of the rolling and side thrust which they produce in locomotive and vehicles ».

Secondly, I feel that the matter is to a large extent independent of rail length. With staggered joints, if a joint is low, the continuous rail opposite to it may maintain its level and the *cross* level thus becomes irregular. On the other hand, with joints in line both rails go down together at a low joint, and the correct cross level is maintained, though vertical movement, which is not so objectionable, is induced.

Furthermore, even with long rails, staggered joints, if not perfectly maintained, may result in the building up of synchronous oscillation, even to a dangerous degree, particularly if the distance between joints happens to correspond with the natural oscillation period of the locomotive at high speed. I therefore suggest that the words « where rail length is comparatively short » be omitted.

Mr. Dubus. — I think that the best solution would be for these Gentlemen to decide upon the English text and submit it to us for translation.

The President. — In the case of the first point, it is merely a question of the correct English terminology.

Mr. Dubus. — Yes there is not much difference.

The President. — In the case of the second point, I suggest that the English delegates should draw up a text after the meeting. *(Agreed.)* As for the question raised by Mr. BAKHLE, I would like to ask Mr. LEDUC if he thinks that this arrangement of a certain proportion of staggered joints should be taken into account.

Mr. Leduc. — The wording mentions joints out of square or staggered. « Out of square » means joints that are not exactly opposite each other; « staggered » means that they come in the middle of the opposite rail.

Mr. Dubus. — It means the same thing in English.

The President. — I do not think we can go into details here. In my opinion the text is sufficiently explicit. Is the Meeting of the same opinion?

Mr. Renda, *Reporter.*— In Italy, there are several hundred kilometres of line on the main lines where the joints are out of square or staggered, using 36 or even 48 m (118′ or 157′) long rails according to working conditions. On the Milan-Bologna-Rome line, a double track line, several hundred kilometres long, the rails are 36 and 48 m long. You will have noticed when travelling over this line, that any defects are not sufficiently serious to upset the running of the trains.

When the joints are out of square the difference is 12 m (39′) in the case of the 36 m rails.

When the joints are staggered, the difference is 18 m (59′). This was a trial length, which up to now has proved satisfactory.

Lt. Col. Wilson. — It seems to be largely a question of maintenance. If maintenance is perfect, staggered joints give you just as good a road as joints in line. Perfection in maintenance is, however, very difficult to achieve, and when packing is faulty, staggered joints are more inclined to cause rolling and side thrust than joints in line.

The President. — I think that under these conditions the question of maintenance might be mentioned. Does the Section agree?

Mr. Renda. — As regards maintenance, it is especially important to use long rails; this means the number of joints is reduced, maintenance is better...

Mr. Leduc. — « ... and easier ! »

The President. — Maintenance is of capital importance, so this point should be insisted upon.

Mr. Renda. — We maintain the track in the ordinary way even when the joints are out of square, but only go over it once a year.

Mr. Leduc. — Maintenance is the more important as the rails are shorter. The effect of using long rails is very considerable. The longer the rails, the less hunting or rolling there is, and the easier the maintenance.

Mr. Renda. — I agree with Mr. Leduc.

The President. — Is the Meeting agreed that the wording should be retained as it is or completed by a paragraph dealing with maintenance and the quality of the maintenance operations? I think everyone is agreed that the importance of maintenance and the effects of hunting should be stressed.

Mr. Bakhle. — Yes, that is all right for the first amendment.

Mr. Leduc. — What do you suggest adding? I must remind you that further on the maintenance of the joint is dealt with in a more general way.

Mr. Lucchini, *Swiss Federal Railways, and Vice-President.* — I would like to remark that the maintenance must be perfect whatever the type of track. In effect if the maintenance of the track is poor, the track will not be worth anything. With long rails, it may be less important — obviously it is better if the maintenance is perfect, but it is not quite as important as in the case of short rails. Consequently, it seems to me that under these conditions, it is not necessary to insist upon the point.

The President. — Gentlemen, I suggest waiting till we get to the paragraph dealing with maintenance, when we will be able to come to a decision with the full details before us.

Mr. Dubus. — Perhaps, it would be a good thing if the delegates concerned agreed a text between them which is acceptable to the Indian delegate and which we will discuss at to-morrow's meeting.

The President. — Do you agree?

(Agreed.)

— Summary 3 was therefore set on one side.

Mr. Dubus. — *Summary 4 :*

4. From the reports received, there does not seem to be any advantage in equating the section modulus of the fishplates with that of the rail.

The President. — Any remarks about this text, Gentlemen?

— Adopted without comment.

Mr. Dubus. — *Summary 5 :*

5. To allow expansion at the rail ends, the holes in the fishplates and the rail must be larger than the diameter of the fishbolts.

Up to the present the general practice has been to make larger holes in the rail than in the fishplate, to minimise the weakening of the latter. On the other hand, it would seem that the adoption of smaller holes in the rail would reduce the risk of cracks which often commence at fishbolt holes; the use of oval holes in the fishplate would then allow the vertical dimension of the holes to be kept to a minimum.

The President. — Are there any objections to this wording?

— Adopted without comment.

Mr. Dubus. — *Summary 6 :*

6. The use of fishbolts of a relatively small diameter not only avoids having large holes in the rail and fishplate, but also makes the maximum possible use of the elasticity of the metal of the bolt.

Mr. Campbell . — I would like to have a check on the translation of the word « elasticity » and more information as to the importance attached to this conclusion.

Mr. R. Lévi. — *French National Railways.* — In our opinion the use of small diameter fishbolts has to be carefully considered for the following reason : When the ganger tightens up the bolts, he exerts a more or less given amount of force. When passing from one diameter to another smaller diameter, this will cause a higher stress; consequently there is greater elastic deformation in the case of fishbolts of smaller diameter.

The term « elasticity » consequently means that there is a greater ratio between the deformations of an elastic character and the force exerted. This was what we meant to express.

To make my meaning more clear, I might add that if the diameter of the fishbolt is reduced, the elastic deformation of the fishbolt is increased from 4/10ths to 5/10th of a millimeter giving an extra 1/10th of a millimeter to take up the play occurring in the fishplate.

The President. — I hope Mr. CAMPBELL is satisfied with this explanation? *(Agreed.)*

— Summary 6 was adopted in its original form.

Mr. Dubus. — *Summary 7 :*

7. It does not seem advisable to support the joint by means of a fishplate formed to act as a bridge.

The President. — No remarks, Gentlemen?

— Adopted without alteration.

Mr. Dubus. — *Summary 8 :*

8. The surfaces by which the fishplate makes contact with the head and the foot of the rail must be inclined to give a wedge effect and to allow for the taking up of wear. The most common practice is for the fishing angles to have an inclination of one in three at both the head and the foot of the rail.

Some systems have adopted an inclination of one in four, others a steeper inclination up to one in two, and sometimes the inclination differs at the head from that of the foot. There do not seem to be any particular advantages, however, in these variations.

The President. — Has anyone any remark to put forward?

— *Adopted without comment.*

Mr. Dubus. — *Summary 9 :*

9. Fishplates are generally made of ordinary rolled steel, having an ultimate tensile strength slightly less than that of the rail. Some systems employ heat treatment but this practice does not seem to be increasing. The tests specified vary somewhat but offer no points of special interest and it is assumed that existing specifications give satisfaction.

The President. — Is everyone in agreement about this wording?

— *Adopted without comment.*

Mr. Dubus. — *Summary 10 :*

10. Perfect alignment of running surfaces of the two rails meeting at the joint is of great importance. Rails should therefore be correctly matched when they are laid, and if possible rails from the same ingot should be placed together. The so-called « perfect » joint of the Belgian Railways is of great interest, but this is rather costly on account of the subsidiary welding which is involved.

Mr. Campbell. — I do suggest that the second sentence in this paragraph is impracticable. I do not think it is fair to put the onus of matching rails on to the permanent way staff, but I do think that the responsibility should rest with the rail makers at the rolling mills. I therefore suggest that, instead of the second sentence, the following should be substituted : « it is therefore important that rails should be rolled symetrically about their axis within very small tolerances ».

Mr. Croom-Johnson, *Reporter.* — You cannot, as Mr. Campbell suggests, place the responsibility on the makers for ensuring that rails are laid in the track in a matched condition. What I suggest here is that such responsibility is solely that of the Permanent Way Engineer.

It is highly desirable that matching of rails in the track should be carried out wherever practicable, and a contributory factor to this being achieved is the suitable stacking in the depot of rails from the same rolling so that they may be selected for issue to the relaying gangs in their proper order.

Mr. Leduc. — I think that the question of tolerances in the manufacture of rails is quite another matter, outside the scope of our investigations. It is a fact that at present these tolerances are relatively wide, since they are of the order of the millimetre.

We have therefore to face the facts and accept the rails as supplied, with such tolerances, and lay them as accurately as possible.

The President. — I think Mr. Leduc is of the same opinion as Mr. Croom-Johnson?

Mr. Leduc. — Entirely.

Mr. Campbell. — I do suggest that it does also come down to a question of economics. If we are to match our rails in the manner suggested, I am afraid our depot charges would be very high, and, therefore, I do not think it is practicable on a big main line railway. We have had this trouble with the rolling mills, and we have had to tighten up tolerances rather than attempt to match up rails.

Mr. Renda. — I would suggest recommending to the rolling mills...

Mr. Leduc. — The text states : « Rails *should therefore be* correctly matched when they are laid and *if possible* laid..., etc. ». So that if it is considered too expensive to do so, it is not done!

Mr. Dubus. — Certainly!

The President. — Consequently, I think Gentlemen that the wording can be left as it is?

Mr. Campbell. — We do not think it is practicable. It is possible, but not practicable from an economical point of view even to match rails.

Mr. Masseron, *Compagnie Fermière des Chemins de fer Tunisiens* (in French). — We have had this difficulty on the Tunisian Railways in the case of rails that were being re-used, and we adopted the Belgian method of the so-called perfect joint, which gives excellent results. It might perhaps be as well to add this sentence : « *This method is to be recommended when laying salvaged rails* ».

The President. — This is a somewhat different question. At the moment we are dealing with the question of tolerances and ingots, and Mr. CAMPBELL insists on a slight alteration in the wording.

Mr. Renda. — I merely made a recommendation.

The President. — Perhaps Mr. CAMPBELL would agree a new wording with those concerned?

Mr. Campbell. — Yes, say it is *ideal* or *most desirable*.

Mr. Leduc. — I propose merely changing one word, which I think will satisfy everyone. Instead of saying : « Rails *must* therefore... »; we might say : « It is *advantageous* for rails... » or « It is *advisable* therefore... ».

Mr. Dubus. — We might say : « It is *desirable* that rails should... ».

Mr. Leduc. — I think it is the word « *must* » that upsets Mr. CAMPBELL.

Mr. Campbell. — Yes, I agree.

Mr. Bouciqué, *Belgian National Railways* (in French). — Mr. President, if mention is to be made of the Belgian method, I should like to add that this has not been applied in order to make good the short-comings of new rails. When the old rails go back to the shops we profit by this opportunity of making use of this solution; it is therefore less a question of new rails than re-usable rails.

Mr. Masseron. — We do the same.

Mr. Bouciqué. — The rails which are sent back to the shops are re-cut and rewelded. It is solely a question of re-use therefore.

Mr. Masseron. — When we re-use rails they are now welded on the main lines by the so-called « perfect » joint method of the S. N. C. B. We are agreed upon this point.

The President. — Does Mr. Bouciqué wish any alteration to be made to the wording?

Mr. Bouciqué. — I think it does not need any modification.

The President. — In view of the remarks made, the wording of Summary 10 will therefore be :

« 10. Perfect alignment of running surfaces of the two rails meeting at the joint is of great importance. It *is desirable* therefore that rails should be correctly matched when they are laid, and if possible rails from the same ingot should be placed together. The so-called « perfect » joint of the Belgian Railways is of great interest, but on account of the subsidiary welding which is involved it is fairly costly, *except where serviceable rails are used.* »

— *Adopted.*

Mr. Dubus. — *Summary 11 :*

11. Correct alignment of running surfaces of the rails in service can be obtained by shims of appropriate thickness, inserted between the fishplates and the head of the rail at the fishing angles. Specially forged fishplates are also useful for this purpose but are less exact.

Mr. Campbell. — I suggest that in the last sentence, after the word « forged » the word « cambered » be inserted, that is « specially forged cambered fishplates are also useful for this purpose, but are less exact ». In English the best word we use is « hog-backed ». A hog-backed fishplate.

Mr. Leduc. — I am wondering if this refers to the same idea. In France, we sometimes use the expression « restamped ». I do not know if this is what Mr. Campbell means?

The President. — It is not quite the same thing.

Mr. Leduc. — I think Mr. Campbell wishes to say that the fishplate is reforged with additional metal in the middle portion? We might say : « reforged with additional thickness ».

The President. — I suggest « reforged with additional thickness » or « restamped and forged ». It is the same thing. Or again : « reforged with increased height ».

Mr. R. Lévi. — Increased height is better.

The President. — The wording of *Summary 11* will therefore be as follows :

« 11. Correct alignment of running surfaces of the rails in service can be obtained by shims of appropriate thick-

ness inserted between the fishplates and the head of the rail at the fishing angles. Specially forged and cambered fishplates *(hog-backed)* are useful for this purpose, but are less exact. »

Are you agreed on this text?

— *Adopted.*

Mr. Dubus. — *Summary 12 :*

12. The more rapid wear at rail ends, resulting from wheel impact, produces battering and burring over of the top surface.

Some systems chamfer the rail ends so that burrs do not form too quickly.

Ends can be built up by welding to restore a smooth running surface and to allow rails to remain longer in the track.

Hardening of the metal by a suitable heat treatment can be expected to reduce these troubles at rail ends provided no appreciable brittleness results.

The President. — Does everyone agree to this wording?

— *Adopted.*

Mr. Dubus. — *Summary 13 :*

13. The use of spring washers to prevent slackening of fishbolt nuts is likely to have appreciable effect in reducing the labour of maintenance.

There does not yet seem to have been close investigation of the possibilities of the elastic fishplate. Where, however, fishplates with spring extensions at the ends have been used, useful results seem to have been obtained.

The President. — No remarks, Gentlemen?

— *Adopted.*

Mr. Dubus. — *Summary 14 :*

14. Careful attention to the level of joints increases their life. It is generally recognised that joints should be attended to more frequently than the rest of the track and at least once a year; systematic packing of joints with small size stone ballast appears particularly satisfactory.

The President. — Now here we come again to the question of *maintenance.*

Mr. Campbell. — Mr. President. I suggest that in the second sentence where it says « It is generally recognised that joints should be attended to... », the word « should » in English translation be altered to « must ». Furthermore, I suggest the words « and at least once a year » should be deleted as I cannot visualise any line we have would only require attention once a year, and I suggest therefore instead the following words should be substituted... « dependent on the nature of the formation, also speed and density of traffic ». Then it would read : « It is generally recognised that joints must be attended to more frequently, *dependent on the nature of the formation, also speed and density of traffic* ».

Mr. Leduc. — I see no objections to it.

The President. — We should therefore say :

« 14. Careful attention to the level of joints increases their life. It *is* generally recognised that joints must be attended to more frequently than the rest of the track, *the frequency of such attention being a function of :*

« *the nature of the formation,*

« *the amount of traffic,*

« *the speed of the trains.*

« Systematic packing of joints appears particularly satisfactory. »

Does this wording satisfy Mr. Campbell? *(Agreed.)*

No further remarks, Gentlemen?

Mr. Dubus. — I should like to make an observation, Mr. President. I do not see that this is closely translated into English. It says in the French text : « La pratique du soufflage pour cet entretien special... » and in the English text : « Systematic packing of joints... ».

Mr. Campbell. — Systematic *shovel* packing.

Mr. Bakhle. — I do not think we should add the word « *shovel* » packing, because it does not always apply. We cannot shovel pack cast iron or pot sleepers.

Mr. Dubus. — Is the President's wording then approved? *(Agreed.)*

We will go on to *Summary 15 :*

15. Insulated block joints present difficulties which can be reduced by the use of fishplates made entirely of insulating material with sufficient mechanical strength; up to the present bakelised wood seems the only material to give reasonable satisfaction.

The President. — Are there any objections to this wording?

— *Adopted without comment.*

Mr. Dubus. — We now come to the *Second Part : Long Welded Rails.*

Summary 16 :

16. It has been learned from experience that rails of a length up to 300 ft. can be laid in the open in main lines without special provisions for expansion.

The President. — Do you agree to the figure of 90 m (300 ft.)? *(Agreed.)*

— *Adopted.*

Mr. Dubus. — *Summary 17 :*

17. Opinion is divided on the necessity to provide special devices for fixing rails to sleepers. It is quite evident that the rails must either be permanently held down tightly or must be fixed by a spring device which creates a permanent pressure between the rail and the sleeper.

Mr. Bakhle. — I am wondering whether it would not be better to combine Summary No. 16 with No. 17, in this manner, « that unless rails are permanently held down tightly, or fixed by a spring device, it would be impracticable to use rails up to 300 ft in the open ». No. 17 is essential to No. 16.

The President. — I do not see why? As regards Mr. Bakhle's suggestion, I would like to point out that these are two different questions; one deals with the length, the other with the fastenings. There is no reason for combining these two summaries.

Mr. Renda. — I think that the question of the fastenings is linked up with that of the rails. We have carried out some very extensive trials. We have in service sections of track with direct fastenings and others with indirect fastenings. The value of indirect fastenings is indisputable. Perhaps this is why Mr. Bakhle has linked up the question of the fastenings with that of the length of the rail?

The President. — It is understood that here it is only question of long rails.

Mr. Dubus. — Mr. BAKHLE agrees that his remark should be incorporated in a later paragraph.

The President. — We will not alter the wording therefore. Are we agreed, Gentlemen? *(Agreed.)*

— Summary 17 was therefore adopted without alteration.

Mr. Dubus. — *Summary 18 :*

18. The number of sleepers per mile, on tracks with long rail lengths, varies considerably on different systems. Some consider that it is advisable to adopt a rather close sleeper spacing.

The President. — No remarks?

— Adopted.

Mr. Dubus. — *Summary 19 :*

19. Neither anti-creep devices nor rail anchorages to the formation appear to be necessary to avoid creep of long rails.

The President. — Do you agree with this, Gentlemen?

— Adopted.

Mr. Dubus. — *Summary 20 :*

20. The sleeper spacing at welded joints can be the same as in the centre of the rails.

The President. — Have you anything to say about this text?

— Adopted.

Mr. Dubus. — *Summary 21 :*

21. In station sidings rails up to 330 ft. long can be laid in the ordinary way and no special precautions are necessary in regard to the attachment to sleepers or the fishing at joints.

The President. — Does this summary call for any comment?

Mr. Campbell. — I am not at all clear as regards the word « stations », which has a different meaning in English, and it should be altered because stations are anywhere throughout the length of the line and there would be very high speeds there the same as there would be on ordinary line. I suggest it is intended to mean station yards, terminal or large intermediate stations.

Mr. Glendinning, *Secretary.* — Station sidings, I think from the French.

The President. — This remark will be taken into account in the English text.

— No other objection being raised, Summary 21 was adopted.

Mr. Dubus. — *Summary 22 :*

22. In tunnels, where temperature variations are small, the rails can be welded from one end to the other. There does not seem to be any need to employ gradually reducing lengths of rail between the long welded lengths and the normal track in the open.

The President. — Any comments, Gentlemen?

— Adopted.

Mr. Dubus. — *Summary 23 :*

23. The material and the cross section of the ballast formation of tracks with long

welded rails is of great importance: to preserve alignment, particularly on curves, a good shoulder of ballast at the ends of the sleepers is essential.

Mr. Campbell. — Just one point. « Formation » in English means the surface below the ballast. I suggest the word « ballast » should be substituted by the word « ballasting », and the word « formation » deleted. It would then read «... and the cross section of the ballasting » in the English version.

The President. — This will be taken into account in the English text. Are there any other remarks.

— *Adopted.*

Mr. Dubus. — *Summary 24 :*

24. Some systems have already carried out tests in the open with rail lengths of several hundred yards and obtained encouraging results; it is very desirable that such tests should be continued on a wide scale.

The elimination of impact at rail joints is certainly a source of considerable economy both in maintenance of track and of rolling stock, it also adds considerably to comfort.

Mr. R. Lévi. — It might be pointed out — though I do not insist upon it — that the use of very long rails also makes it possible to stagger the joints without any difficulty, and consequently reduce shocks still further.

The President. — Does Mr. Robert Lévi want any alteration in the wording?

Mr. R. Lévi. — I do not think it is essential, but it might be considered useful to mention this point.

Mr. Dubus. — This remark might be included in the report of the meeting.

Mr. R. Lévi. — It is not pointless to recall that the use of very long rails makes it possible to do away with shocks almost entirely, at least apparently!

Mr. Dubus. — Will Mr. R. Lévi please draw up a text on these lines.

Mr. Lucchini. — Since it is question of long rails, should not the point be further stressed, stating that it is desirable to recommend, in order to arrive at the ideal solution... This ideal solution is never actually reached, but the expression is used in the hopes that we will get as near perfection as possible.

Mr. Dubus. — We might say : « It is *highly* desirable... ».

Mr. Leduc. — Or else : « It is *particularly* desirable... ».

The President. — Does the meeting agree to the addition of this word? *(Agreed.)*

— *Summary 24 was adopted in the following amended form :*

« 24. Some systems have already carried out tests in the open with rail lengths of several hundred yards, and obtained encouraging results; it is *most* desirable that such tests should be continued on a wide scale.

« The elimination of impact at rail joints is certainly a source of considerable economy both in maintenance of track and rolling stock, it also adds consider-

ably to comfort. *The use of long rails also gives the advantage of facilitating the staggering of joints.* »

Mr. Dubus. — *Summary 25 :*

25. It should be possible in the near future to determine from experience the type of joint (ordinary or special) to be employed for joining long rail lengths together, or connecting these to junction work and insulated block joints, etc.

Mr. R. Lévi. — I suggest deleting the parenthesis : « (ordinary or special joints)». I do not think this would cause any inconvenience whereas retaining this parenthesis seems to imply that it does not matter very much whether ordinary or special joints are used. Now, it is my belief a priori that if we are to make trials that will really give results, all possible safety measures should be included. So that it would be necessary to use special joints as much as possible. I might add that the use of special joints costs relatively little. The switch type joint which we are making at the present time in France involves an increase in expenditure approximating to some 6 m of track. If nothing but 60 m rails were used, this would involve an increase of 10 % in the cost of the material. If the rails were 600 m long, it becomes not an excessive cost, but an extremely low cost.

Consequently, I think it is inadvisable to retain the parenthesis which seems to imply that ordinary and special joints make no difference. On the contrary, we should state that we should endeavour to reduce the cost of the special joints.

The President. — Does everyone agree that the text in parenthesis : « (ordinary or special joints) » should be deleted ? *(Agreed.)*

— *Adopted subject to the parenthesis being deleted.*

Mr. Dubus. — *Summary 26 :*

26. Theoretical studies and the tests which have been made give varying results for the forces in the rail and the resistance of the track as a whole to these forces. It would be advantageous if these studies and experiments were continued on a uniform basis with common and well defined terms, so that the results could be easily compared. These should be concentrated on the actual tensions and compressions in the rails at different temperatures with different types of track. It would also be useful to find out by experiment the maximum resistance which different types of track can develop against movement as a result of the forces in the rail. Such studies and tests should enable a decision to be made as to the best temperature at which long rails should be laid.

Mr. Campbell. — Just a relatively small point. In the third sentence I suggest, instead of « tension and compressions », the word « stresses ». And, in the fourth sentence, instead of the word « track » I would like the words « permanent way and ballast » substituted, because one can get different combinations, such as ash ballast, stone, slag ballast, also different types of track, with bull head, flat bottom rails, wooden sleepers, concrete sleepers. I would like these amendments in the English version.

I think actually « permanent way and ballast ». These are the two main components of the railway that we run on. I would prefer these.

The President. — Are we agreed about Summary 26, apart from the comments on the English text ?

— *Adopted.*

Mr. Dubus. — We now come to the *Third Part : Rail gaps in relation to temperature.*

Summary 27 :

27. The general experience acquired is that the gaps between rails can be less than those theoretically calculated on a free expansion basis — in fact they can be reduced to a half or even less. The more the type of track resists creep, the smaller the gap can be.

The President. — Are you agreed about the wording of this Summary, Gentlemen?

— *Adopted without comment.*

Mr. Dubus. — *Summary 28 :*

28. Unless special arrangements are made for the joint, this is a weak point in the track which may be the origin of a buckle. It is therefore important that the play allowed for expansion, having regard to the type of track concerned, is not all taken up at too low a temperature, otherwise there is risk that excessive forces will arise in the rail. In the course of maintenance work, and particularly before the first warm weather of the year, the rail gaps should be restored to normal. It is, however, permissible to allow some tolerance in the gaps compared to that provided at the time of laying.

Mr. Campbell. — There is a small point in the first sentence. I do not like the word « origin », and I suggest « focal point » should be substituted. In the second sentence instead of the word « play », because that suggests side movement, I would suggest substituting the word « space », and finally in the third sentence, the word « warm » I would suggest be deleted and the word « hot » be substituted.

Lt. Col. Wilson. — In the third sentence « In the course of maintenance work and particularly before the first warm weather of the year » I would suggest it be specifically mentioned that fishplates should be loosened and the rail gaps be restored to normal even if the rail gaps are found to be approximately correct. Even then there is great value in loosening fishplates to ensure there is no binding.

Mr. Leduc. — This is one of the ways of restoring the rail gaps to normal; we did not wish to go into all the methods used.

Lt. Col. Wilson. — I must make it clear. I mean that even if rail joints were found to be correct, fishplates should still be loosened.

Mr. Leduc. — I would agree to a few words being added about this. It is an idea which has not been expressed here, i.e. the suppression of the stresses which may occur in the rails, even when the joint gaps are open.

Mr. Dubus. Cannot we arrive at a compromise?

The President. — I suggest the delegates concerned should agree the wording between them, in order to please everyone.

Mr. Leduc. — In my opinion, it is better to have a certain amount of stress in the rails, if such a stress is not likely to give rise to trouble. To suppress it may result in distributing the stresses by closing up the gaps and preventing expansion occurring at the ends of the rail near the joint.

Mr. Dubus. — If we said : « It is necessary to lay down *in particular...* ».

Mr. Campbell. — The importance, I think, of Col. WILSON's suggestion is that it relates to joints where the expansion gaps may be correct, and he wants to make certain that in such cases fishplates are either loosened or removed. We, in Great Britain, oil fishplates every year, on main lines, and on secondary lines every two years, so that we can make sure any corrosion there may be does not sieze the rail and prevent expansion.

The President. — I think that after the words : « ... the rail gaps should be restored to normal » we might add the following words « *the fishbolts may have to be unscrewed* ».

Mr. R. Lévi. — It is not a question of the wording. In fact, I do not know if all the Railways consider it useful to actually loosen the joints.

Mr. Bouciqué. — In Belgium, we loosen them every year.

Mr. Dubus. — Chiefly to prevent buckling.

Mr. Leduc. — It might be said that as soon as some of the fishplates allow the ends of the rail to expand, such expansion must be able to take place through the fishing. The way the fisplate is made must make expansion possible.

The President. — To say that the fishbolts may have to be unscrewed, does not mean that it is obligatory to do so.

Mr. Leduc. — The statement might be made in a more general fashion.

Mr. R. Lévi. — The sentence : « It is therefore necessary... » might be completed by the words : « ... *and to make sure that the fishplates are playing their part properly* ».

Mr. Leduc. — I would say : « ... *and to make sure the fishplates still allow the rails to expand in the way in which they are designed to do so* ».

The President. — In practice, this means unscrewing the fishbolts, does it not?

Mr. Renda. — The maintenance of the fishbolts and fishplates is done before expansion.

The President. — I suggest saying : « It is therefore necessary to restore, whilst carrying out the maintenance, and before the first warm weather, the normal rail gaps. *The fishbolts may have to be unscrewed.* It is however... ».

Mr. Leduc. — I prefer Mr. R. LÉVI's wording which consists in adding the words : « ... *and to make sure the fishplates allow the rails to expand* ».

Lt. Col. Wilson. — I suggest an additional sentence to say that the rail joints should be examined to ensure that there is sufficient freedom for expansion to take place.

Mr. R. Lévi. — Does this addition mean that this work should be done in every

case, or only at the period already mentioned, before the warm weather? In this case this should be mentioned in the last sentence.

Mr. Campbell. — Unless you add another sentence. « In any case rail joints should be examined to ensure that the rail can move with reasonable ease ».

I omitted to add « by loosening the fishplates and bolts ». That should be in.

Mr. Leduc. — I would have preferred this more general formula : « ... *and to make sure the fishplates always allow the rails to expand* ». There may be some fishplates without any fishbolts; there are some, the pincher type fishplates in which the parts wedge themselves together.

The President. — I find the wording rather too general and not sufficiently precise.

Mr. R. Lévi. — I do not see how it is possible to do otherwise and must point out that checking the rail gaps and making sure the joints are functioning properly take place under the same conditions. It is therefore the same phrase.

The President. — Mr. Leduc is thinking of the unscrewing of the fishbolts.

Mr. R. Lévi. — Are they not tightened up again afterwards?

The President. — Naturally.

Mr. Leduc. — We always endeavour not to be too detailed in order to get a general wording which can apply to all types of installations.

Mr. Masseron. — We might limit ourselves to stating : « *checking the regularity* of the joint gaps ».

The President. — That is not the point.

Mr. Leduc. — It is not sufficient. The idea is to make sure that the fishplates can allow expansion...

The President. — And that there are no undue stresses.

Mr. Leduc. — With the classic type of fishplate, obviously it is necessary to unscrew the fishbolts, perhaps open the fishplate, grease it and then screw it up again. It is possible that there are other types of fishplates with which different methods have to be used.

The President. — These other types are very few in number!

Mr. Leduc. — I suggest saying : « ... *and make sure that the fishplates allow expansion to take place, in particular by unscrewing and screwing up the fishbolts...* » if more precision is required!

The President. — I think that Mr. Leduc should agree the wording with Mr. Campbell in order to draw up a satisfactory text.

Mr. Leduc. — I think in fact this is the only possible way to settle the matter.

The President. — Apart from this alteration, is the text adopted?

— *The Meeting agreed and after the paragraph in dispute had been agreed upon, the final wording adopted was as follows :*

« 28. Unless special arrangements are made for the joint, this is a weak point in the track which may be the focal point of a buckle. It is therefore important that the space allowed for expansion, having regard to the type of track concerned, is not all taken up at too low a temperature, otherwise there is risk that excessive forces will arise in the rail. In the course of maintenance work, and particularly before the first hot weather of the year, the rail gaps could be restored to normal. *Examination should be made to ensure the fishplates will allow the rail ends to move freely. This might involve for example the unscrewing or the screwing up of the fishbolts.*

« It is, however, permissible to allow some tolerance in the gaps compared to that provided at the time of laying. »

Mr. Dubus. — *Summary 29 :*

29. Checking of joint gaps should be done at times of day when the temperature is not particularly high.

The President. — Has anyone anything to say about this wording?

— *Adopted without comment.*

Mr. Leduc. — Mr. President, I would like to go back to an idea put forward some time ago, regarding the special maintenance required in the case of staggered joints. I think in the end there is not much point in mentioning it. In effect, if we draw attention to the need for particularly careful maintenance of staggered joints, it would seem to imply that when the joints are opposite each other less thorough maintenance is needed, which is wrong. I suppose everyone will agree with me?

Mr. Bakhle. — I have an amendment on this to discuss with Mr. LEDUC.

The President. — As no one else wishes to say anything, I declare the meeting at an end.

Meeting of the 28th September 1950.

MR. JULIEN IN THE CHAIR.

— The meeting started at 9 a.m.

The President. — Gentlemen, several members of Section III expressed a wish to take part in the meeting we are devoting to discussing Question III : « New technical methods adopted for the design and construction of large marshalling yards ». As these Gentlemen are detained necessarily by the discussions on the summaries for Question IX (Signalling), they cannot be with us this morning.

Consequently, if you are agreeable we are going to postpone the discussion of Question III until our meeting Monday, October 2nd. *(Agreed.)*

I suggest that we now go back to Summary 3 of Question II, which was not settled at our last meeting. At the end of this meeting Mr. Bakhle left an amendment to Summary 3 of Part I at the office. I will ask Mr. Dubus, *Principal Secretary*, to read it to us.

Mr. Dubus. — Mr. Bakhle's amendment is worded as follows :

« The most general arrangement is for joints to be opposite each other. Whilst the use of joints out of square, viz. with short stagger, or by half rail length, continues to be employed in some instances on curves to assist in better maintenance of alignment, the use of mid-staggered joints has gradually falled into disfavour on many systems, probably because of the lurching which they tend to induce in rolling stock. As, however, there may be considerable advantages to be obtained from the use of joints out of square, it would be of interest to try out short staggering, say, equal to half the wheel base of a bogie truck, an arrangement which would tend to avoid lurching in rolling stock. »

The President. — Does anyone wish to say anything about this amendment?

Mr. Renda. — We cannot accept such an amendment which is far too radical as far as staggered joints are concerned.

The President. — Consequently Mr. Renda does not agree to it.

Mr. Renda. — We are agreed as far as out of square but not as far as staggered joints are concerned. I think this text might be adapted in the sense of the summaries adopted at yesterday's meeting.

Mr. Bakhle. — It is not different. What was different in yesterday's proposition : « the use of staggered joints elsewhere which was once fairly frequent practice has gradually fallen into disfavour ». We are saying the same thing.

The point there is that the reason why the practice is falling into disfavour is probably because of lurching, and lurching is most accentuated when track is laid to mid-stagger.

Mr. Renda. — I think that the wording suggested is very general and in fact allows everyone to follow whatever course he wishes. I might add on the other hand that if 60 m long rails are used, the joints are staggered at 30 m, which does not present any difficulty.

The President. — I think that the wording suggested yesterday is sufficiently general and cover nearly every case. In addition, it seems to state approximately the same thing as the amendment now before us, apart from the mention of half a bogie length.

Mr. Renda. — We might retain having them out of square at half a bogie length, because out of square is general, whether it is 1 m, 12 m or 20 m out.

The President. — This text leaves complete freedom of action.

Mr. Renda. — Absolutely.

Mr. Bakhle. — My submission is that my amendment proposed is not really different from what was in the original text.

The President. — That is certainly my opinion; it is more or less the same thing. If Mr. BAKHLE wishes mention to be made of a half bogie length, we might add to the text a statement that it is interesting to undertake trials with joints out of square by a half bogie length.

Mr. Renda. — Just so.

Mr. Bakhle. — My point is this proposition of putting in a short stagger equal to half the wheel base of the bogie. This has no relation to the length of the rail. This sentence in the original reads : « On modern track, however, with longer rails, it would seem that better results can be obtained from the use of staggered joints, and it would be of interest, therefore, to renew experiments in this direction ». It does not make any difference to the length of the rail. Rails can be 36 or 42 feet long. It is not the length of rail which matters but the position of the joint in relation to the bogie truck.

The President. — We might say that trials might take into account having the joints out of square by half the distance between bogies.

Mr. Croom-Johnson. — I would like to support the amendment in the form we more or less decided yesterday, because it confirms what we said in the original report, but takes note of the more recent experience on the Indian Railways. I think the amendment as it stands should stay.

Mr. Bakhle. — In other words you are supporting my amendment.

Mr. Croom-Johnson. — Yes.

Mr. Renda. — Mr. President, I think that since the wording of Summary 3 was discussed at yesterday's meeting, we cannot go back and alter it today when many of those interested in this question are absent. To do so would be to court their remarks and reproaches. In reality, I do not think such a way of proceeding is permissible.

The President. — This point was covered yesterday, as we announced that a new wording was being prepared.

Mr. Renda. — Was this amendment proposed in agreement with Mr. LEDUC, *Special Reporter*, and the other members concerned ?

The President. — I would like to know if Mr. LEDUC is aware of the suggestion.

Mr. Dubus. — Mr. LEDUC does not agree to Mr. BAKHLE's amendment.

Mr. Renda. — I am in favour of the Special Reporter's text. If a special suggestion must be made, a new discussion must be undertaken since several members of Section I are absent from this morning's meeting.

Mr. Campbell. — I would also like to support this amendment, as drafted, but I wonder if it would be helpful in getting it agreed generally if we inserted after « mid-staggered joints have gradually fallen into disfavour » the words « on many railways ».

Mr. Dubus. — On many systems?

Mr. Campbell. — Yes, « systems or administrations ».

Mr. Lucchini, *Vice-President.* — I quite agree that it is impossible to go into every detail in our summaries, and it is better to keep it as the Special Reporter worded it.

I agree with Mr. Renda in the sense that it is not possible to review this question in every detail.

The President. — Gentlemen, I think there is only one way of settling the matter, and that is by taking a vote. We We will put Mr. Bakhle's amendment to the vote.

— This was voted upon, by the raising of hands, and Mr. Bakhle's *amendement was rejected by 10 votes to 7.*

The President. — Consequently, the text of Summary 3 will be retained in its present form.

Gentlemen, we have now gone through our aggenda, and I declare the meeting closed.

DISCUSSION AT THE PLENARY MEETING.

Meeting held on September 29th, 1950.

Dr. Eng. G. di Raimondo, President, in Chair.
General Secretaries : Mr. P. Ghilain and Dr. Eng. M. Valdivieso.
Assistant General Secretary : Mr. Ch. E. Whitworth.

Mr. Ghilain, *General Secretary* (in French). — We now come to Question II, the Summaries for which were published in the *Daily Journal of the Congress*, No. 3 dated 28th September 1950.

— *These Summaries raised no remarks.*

The President (in French). — We will therefore consider the Summaries for Question II as adopted.

SUMMARIES.

FIRST PART.

Fishplated rail joints.

« 1. It is apparent from a study of « the reports received that there has « been no considerable modification to « the traditional fishplated joint, which « consists of two fishplates, short or « long, strengthened to varying degrees « by lower or upper ribs, and held in « place by bolts through the web of the « rail. Complicated arrangements to « provide a continuous running surface « to the rail at the joint are not found « in use to give the advantages hoped « for by their inventors. Slant cutting « of the rail ends is not favoured in « current practice.

« 2. To avoid excessive fatigue in the « constituent parts of the joint it is usual « to reduce the sleeper spacing adjacent « to rail ends. The most general prac- « tice is to support the rail on two « independent sleepers, closely spaced, « to allow of adequate packing in pre- « ference to a double sleeper. As to the « joint supported on a single sleeper, « this now seems to be falling into « disuse, except in the U. S. A. and in « India, where from information recei- « ved it is still widely practised.

« 3. The most general arrangement is « for joints to be opposite each other. « Whilst the use of joints out of square « or staggered by half a rail length con- « tinues to be employed in some in- « stances on sharp curves to assist in « the maintenance of alignment, the use « of staggered joints elsewhere which « was once fairly frequent practice has « gradually fallen into disfavour, proba- « bly because of the rolling which they « induce in rolling stock on tracks « where the rail length is comparatively « short. On modern track, however,

« with longer rails it would seem that « better results can be obtained from the « use of staggered joints, and it would « be of interest, therefore, to renew « experiments in this direction.

« 4. From the reports received, there « does not seem to be any advantage in « equating the section modulus of the « fishplates with that of the rail.

« 5. To allow expansion at the rail « ends, the holes in the fishplates and « the rail must be larger than the dia- « meter of the fishbolts.

« Up to the present the general prac- « tice has been to make larger holes in « the rail than in the fishplate, to mini- « mise the weakening of the latter. On « the other hand, it would seem that the « adoption of smaller holes in the rail « would reduce the risk of cracks which « often commence at fishbolt holes; the « use of oval holes in the fishplate would « then allow the vertical dimension of « the holes to be kept to a minimum.

« 6. The use of fishbolts of a rela- « tively small diameter not only avoids « having large holes in the rail and « fishplate, but also makes the maximum « possible use of the elasticity of the « metal of the bolt.

« 7. It does not seem advisable to « support the joint by means of a fish- « plate formed to act as a bridge.

« 8. The surfaces by which the fish- « plate makes contact with the head and « the foot of the rail must be inclined « to give a wedge effect and to allow « for the taking up of wear. The most « common practice is for the fishing « angles to have an inclination of one « in three at both the head and the « foot of the rail.

« Some systems have adopted an « inclination of one in four, others a « steeper inclination up to one in two, « and sometimes the inclination differs « at the head from that of the foot. « There do not seem to be any parti- « cular advantages, however, in these « variations.

« 9. Fishplates are generally made of « ordinary rolled steel, having an ulti- « mate tensile strength slightly less than « that of the rail. Some systems employ « heat treatment but this practice does « not seem to be increasing. The tests « specified vary somewhat but offer no « points of special interest and it is « assumed that existing specifications « give satisfaction.

« 10. Perfect alignment of running « surfaces of the two rails meeting at « the joint is of great importance. It « is desirable therefore that rails should « be correctly matched when they are « laid, and if possible rails from the « same ingot should be placed together. « The so-called « perfect » joint of the « Belgian Railways is of great interest, « but on account of the subsidiary weld- « ing which is involved it is fairly costly, « except where serviceable rails are « used.

« 11. Correct alignment of running « surfaces of the rails in service can be « obtained by shims of appropriate « thickness inserted between the fish- « plates and the head of the rail at the « fishing angles. Specially forged and

« cambered fishplates (hog-backed) are « useful for this purpose, but are less « exact.

« 12. The more rapid wear at rail « ends, resulting from wheel impact, « produces battering and burring over « of the top surface.

« Some systems chamfer the rail ends « so that burrs do not form too quickly.

« Ends can be built up by welding to « restore a smooth running surface and « to allow rails to remain longer in the « track. Hardening of the metal by a « suitable heat treatment can be expect- « ed to reduce these troubles at rail ends « provided no appreciable brittleness « results.

« 13. The use of spring washers to « prevent slackening of fishbolt nuts is « likely to have appreciable effect in « reducing the labour of maintenance.

« There does not yet seem to have « been close investigation of the possi- « bilities of the elastic fishplate. Where, « however, fishplates with spring exten- « sions at the ends have been used, « useful results seem to have been « obtained.

« 14. Careful attention to the level of « joints increases their life. It is gener- « ally recognised that joints must be « attended to more frequently, than the « rest of the track, the frequency of « such attention being a function of :

« the nature of the formation;
« the density of the traffic;
« the speed of the trains.

« Systematic packing of joints with « small size stone ballast appears parti- « cularly satisfactory.

« 15. Insulated block joints present « difficulties which can be reduced by « the use of fishplates made entirely of « insulating material with sufficient « mechanical strength; up to the present « bakelised wood seems the only mater- « ial to give reasonable satisfaction.

SECOND PART.

Long welded rails.

« 16. It has been learned from « experience that rails of a length up « to 300 ft. can be laid in the open in « main lines without special provisions « for expansion.

« 17. Opinion is divided on the « necessity to provide special devices « for fixing rails to sleepers. It is quite « evident that the rails must either be « permanently held down tightly or « must be fixed by a spring device which « creates a permanent pressure between « the rail and the sleeper.

« 18. The number of sleepers per « mile, on tracks with long rail lengths, « varies considerably on different sys- « tems. Some consider that it is advis- « able to adopt a rather close sleeper « spacing.

« 19. Neither anti-creep devices nor « rail anchorages to the formation « appear to be necessary to avoid creep « of long rails.

« 20. The sleeper spacing at welded « joints can be the same as in the centre « of the rails.

« 21. In station sidings, rails up to « 330 ft. long can be laid in the ordin-

« ary way and no special precautions « are necessary in regard to the attachment to sleepers or the fishing at « joints.

« 22. In tunnels, where temperature « variations are small, the rails can be « welded from one end to the other. « There does not seem to be any need « to employ gradually reducing lengths « of rail between the long welded lengths « and the normal track in the open.

« 23. The material and the cross section of the ballasting of tracks with « long welded rails is of great importance; to preserve alignment, particularly on curves, a good shoulder of « ballast at the ends of the sleepers is « essential.

« 24. Some systems have already « carried out tests in the open with rail « lengths of several hundred yards, and « obtained encouraging results; it is « most desirable that such tests should « be continued on a wide scale.

« The elimination of impact at rail « joints is certainly a source of considerable economy both in maintenance « of track and rolling stock, it also adds « considerably to comfort. The use of « long rails also gives the advantage of « facilitating the staggering of joints.

« 25. It should be possible in the « near future to determine from experience the type of joint to be employed « for joining long rail lengths together, « or connecting these to junction work « and insulated block joints, etc.

« 26. Theoretical studies and the « tests which have been made give varying results for the stresses in the rail « and the resistance of the track as a « whole to these forces. It would be « advantageous if these studies and « experiments were continued on a « uniform basis with common and well « defined terms, so that the results could « be easily compared. These should be « concentrated on the actual stresses in « the rails at different temperatures « with different types of track. It « would also be useful to find out by « experiment the maximum resistance « which different types of permanent « way and ballast can develop against « movement as a result of the stresses « in the rail. Such studies and tests « should enable a decision to be made « as to the best temperature at which « long rails should be laid.

THIRD PART.

Rail gaps in relation to temperature.

« 27. The general experience acquired is that the gaps between rails can « be less than those theoretically calculated on a free expansion basis — in « fact they can be reduced to a half or « even less. The more the type of track « resists creep, the smaller the gap « can be.

« 28. Unless special arrangements « are made for the joint, this is a weak « point in the track which may be the « focal point of a buckle. It is therefore « important that the space allowed for « expansion, having regard to the type « of track concerned, is not all taken up « at too low a temperature, otherwise « there is risk that excessive forces will

« arise in the rail. In the course of « maintenance work, and particularly « before the first hot weather of the « year, the rail gaps could be restored « to normal. Examination should be « made to ensure the fishplates will « allow the rail ends to move freely. « This might involve for example the « unscrewing or the screwing up of the « fishbolts.

« It is, however, permissible to allow « some tolerance in the gaps compared « to that provided at the time of laying.

« 29. Checking of joint gaps should « be done at times of day when the « temperature is not particularly high. »

[656 .212 .5]

QUESTION III.

New technical methods adopted for the design and construction of large marshalling yards.

Lay-out and equipment :
Site and importance of siding groups;
Lay-out of connections at entrance to groups;
Longitudinal and cross sections;
Braking installations (Retarders);
Control of point (switch) operation;
Telecommunications;
Lighting;
Staff buildings, etc.

Preliminary documents.

Report (Denmark, France and Colonies, Italy, Luxemburg, Netherlands and Colonies, Norway, Poland, Switzerland and Syria), by M. MARCHAND (See *Bulletin* for April 1950, p. 363 or separate issue No. 8).

Report (Austria, Belgium and Colony, Bulgaria, Czechoslovakia, Finland, Greece, Hungary, Jugoslavia, Portugal and Colonies, Rumania, Spain, Sweden and Turkey), by J. VAN RIJN (See *Bulletin* for April 1950, p. 431 or separate issue No. 10).

Report (America (North and South), Burma, China, Egypt, Great Britain and North Ireland, Dominions, Protectorates and Colonies, India, Iran, Iraq, Malay States and Pakistan), by J. I. CAMPBELL, and J. W. WATKINS (See *Bulletin* for April 1950, p. 483 or separate issue No. 12).

Special Reporter : M. MARCHAND (See *Bulletin* for October 1950, p. 2028).

DISCUSSION BY THE SECTION.

Meeting of the 2nd October 1950.

PRESIDENT : MR. R. CLAUDON.

— The meeting began at 9 a. m.

The President (in French). — Gentlemen, to-day we have to consider Question III, and I suggest we do this work as follows. If you want, as I hope you will, to exchange opinions upon questions which are not effectively dealt with in the Summaries to Question III, but which

are closely bound up with the subject, you can do so to-morrow, and to-day we will limit the work to an examination of the actual summaries.

In this way, the wording adopted can be submitted to the Secretariat to-day, in plenty of time for the Plenary Meeting on Wednesday.

Do you agree to this procedure? *(Agreed).*

The President. — Will Mr. DUBUS, *Principal Secretary*, please be good enough to read the Summaries of Mr. MARCHAND's Special Report.

Mr. Dubus (in French). — We will begin with the chapter : *General.*

Summary 1 :

1. The methods adopted in the design and construction of marshalling yards are based on the fundamental principles laid down at the Congresses of London (1925) and Madrid (1930); they aim at increasing efficiency, reducing costs and enlarging shunting capacity by the application of « mechanisation » and the planning of rational lay-outs and profiles.

The President. — Are you agreed about this text, Gentlemen?

— *Adopted without comment.*

Mr. Dubus. — *Summary 2 :*

2. Each new scheme presents a particular problem, from the points of view of cost of construction and economy in working. It is desirable that the study of schemes should be advanced as far as possible by competent staff of the department responsible for operations, before constructional plans are prepared (commenced).

Mr. Renda *Italian State Railways*, (in French). — I think that the conception of the preliminary study is not in the hands of the same department on all the railways. The summary mentions the operating department, whereas in reality this is a matter for the permanent way department in consultation with the operating and traction departments.

I think therefore it would be better to keep the summary rather more general and refer to the Administration.

The President. — Would you say : the departments *responsible* for the operation?

Mr. Renda. — No, the departments *concerned.*

Mr. Marchand *Special Reporter*, (in French). — Mr. President, the text corresponds to the desire expressed by most of the Administrations to let the operating department have its say in new studies. I think it is the usual practice for the departments to study very closely the conditions under which the installations will be laid out, in order to get the highest possible efficiency. I would like to insist that the sentence would not have much meaning if we left out the expression « operating department » as this is the main point. It is question of the skilled staff of this department.

The President. — Gentlemen, I suggest the following wording which I think will satisfy Mr. Renda : « *using department* ».

Mr. Renda. — I agree.

The President. — Has no one else anything to say about this amended wording?

Summary 2 was adopted with the alteration of « the department responsible for operations » to « using departement ».

Mr. Dubus. — *Summary 3 :*

3. The modernisation of existing yards, often situated in congested areas, may present difficulties of realisation owing to the want of available space.

The President. — No comments, Gentlemen?

— *Adopted without alteration.*

Mr. Dubus. — *Summary 4 :*

4. The construction of new yards involves the finding of suitable sites from the point of view of superficial area and contour; when the sites selected are remote from populated areas, it is necessary to consider means of transport and housing accommodation for staff.

Mr. Barrington-Ward, *British Railways.* — I think you ought to add to this point, it also means more often than not the re-allocation or reconstruction of the locomotive depots, which is also a very expensive thing.

Mr. Marchand. — This is a subject which the reporters purposely left out as it seemed to them to lie outside the question as set. The question of the traction installations was merely mentioned as regards the connection between the marshalling yard and the locomotive sheds.

The President. — Does Mr. Barrington-Ward insist upon an addition to the text?

Mr. Barrington-Ward. — If you make a new yard, then you have to consider the construction of a new locomotive depot. Should that not be under summary 4.

The President. — Perhaps it is not absolutely essential to build a new shed, it will be sufficient if the connections are carefully studied. If Mr. Barrington-Ward insists, I think we might meet him by saying « The construction of new marshalling yards and *eventually of the necessary locomotive depots, involves...* ».

Mr. Barrington-Ward. — Yes. Agreed.

The President. — The text will therefore be revised as follows :

« 4. The construction of new yards *and, eventually, of the necessary locomotive depots,* involves the finding of suitable sites from the point of view of superficial area and contour; when the sites selected are remote from populated areas, it is necessary to consider means of transport, and housing accommodation for staff. »

— *Adopted in this modified form.*

Mr. Dubus. — *Summary 5 :*

5. Except where special cases or local circumstances render all other solutions impracticable, the construction of double yards, comprising two yards, side by side, each dealing with an opposing flow of traffic, is justified only when the number of vehicles to be dealt with exceeds the capacity of a single hump yard.

The President. — Does everyone agree to this wording?

— *Adopted without comment.*

Mr. Dubus. — *Summary 6 :*

6. Yards on the gravitation principle, wholly or partially, are only constructed where a suitable profile exists.

Mr. Train, *British Railways.* — I was wondering if that is strictly correct, Mr. President. I would suggest for consideration adding the words « *or can be made* », i. e... « are only constructed where a suitable profile exists, or can be made ».

Mr. Marchand. — I do not see any objection.

— No other comments being made, Summary 6 was adopted in the following form :

« 6. Yards on the gravitation principle, wholly or partially, are only constructed where a suitable profile exists *or can be made.* »

Mr. Dubus. — We now come to the chapter :

Location of groups of sidings and connecting lines.

Summary 7 :

7. In addition to reception and sorting groups, which are usually laid out in sequence, large yards should have separate marshalling and departure groups, also « recess » facilities as necessary.

From the point of view of operating convenience, and expeditious transfer movements of vehicles, it is recommended that the following be provided :

— departure groups in continuation of the sorting group;

— marshalling group and recess lines at the sides of the sorting group.

Mr. Barrington-Ward. — May I ask what is meant by « recess » ?

Mr. Glendinning. — Storage or lay-by.

Mr. Barrington-Ward. — I suggest the word « storage » is used in the English.

Mr. Marchand. — I do not think that the English word « storage » is a good translation of the French expression « *faisceaux de relais* ». This is used in connection with trains which have not to be shunted in their entirety, but the locomotives have to be changed, or the wagons inspected, or wagons added or taken off. It is a question therefore of trains which only spend a time in the yard for some operations other than shunting operations.

The President. — If Mr. BARRINGTON-WARD agrees to the definition just given, the Bureau will take responsibility for amending the English text accordingly. *(Agreed.)*

— Instead of the expression « recess facilities » it was decided to use the phrase « storage and lay-by facilities » in the English text.

With this reservation, the text of Summary 7 was adopted.

Mr. Dubus. — *Summary 8 :*

8. The number of sidings in the different groups and their effective length are decided by the department responsible for operating, according to service requirements, taking into consideration future developments and having regard to the space available.

The President. — Have you any remarks to make about this summary, Gentlemen ?

— Adopted without comment.

Mr. Dubus. — *Summary 9 :*

9. The arrangements of communicating and connecting lines, and the siting of the leads of the groups of sidings should be studied with the object of facilitating the movement of trains and locomotives so as to reduce to the absolute minimum interference between trains, locomotives and shunting operations. In these circumstances constructional works should be undertaken in order to eliminate the more restrictive cross-movements.

The President. — Does this text call for any comment?

— *Adopted without comment.*

Mr. Dubus. — *Summary 10 :*

10. The risk of interference between shunting operations and trains can be appreciably reduced by the provision of independent facilities; at large yards the provision of direction reversing loops or equivalent facilities permits, in conjunction with the use of departure groups, of one-way working which facilitates operation.

The President. — Do you agree about this summary, Gentlemen?

— *Adopted without comment.*

Mr. Dubus. — *Summary 11 :*

11. The layout at the heads of the groups of sidings should be as simple as possible in order to reduce the length of shunt.

The provision of double humping lines at the same level enables an appreciable reduction to be made in the length of the head of the reception lines nearest to the hump; it also affords the possibility of more continuous shunting when two humping locomotives are employed.

On the other hand humping lines at different levels (winter and summer) have the disadvantage of lengthening the layout and the length of shunt. Moreover they are unnecessary when the yard is equipped with rail brakes.

Mr. Rostern, *British Railways.* — I would like to suggest that the possibility of « more continuous shunting » can be applied whether there are two humping locomotives employed or not. The position is merely that they are asking to keep the reception lines as near to the hump as possible.

Mr. Marchand. — When there is only one line over the hump, it is necessary to arrange a fairly long interval between shunting two trains to enable the second train to be shunted to be pushed up to the hump. The time required corresponds to the minimum distance between the head of the siding group and the hump. It might be of the order of 100 or 200 m (110 or 220 yards) according to the layout. On the other hand, when there are two adjacent lines over the hump, it is possible to bring the second train to be shunted right up to the hump so that everything is ready to shunt it as soon as the shunting of the first train is finished.

Mr. Barrington-Ward. — A more economical way of doing this is to have 6 or 8 reception roads in tandem to the hump, with two shunt roads, and whilst one can be off over the hump the engine can be running round to put the other one over. There is no need to have this additional hump put in if reception roads cannot be in tandem to each other. Is it necessary really to have this additional hump line you talk about? You hump straight over the line to your reception yard.

The President. — What does the Special Reporter suggest?

Mr. Marchand. — I think there is a misunderstanding, as when there is only a single line to the hump, it is impossible to avoid have an interval of two or three minutes between two consecutive shunts, even when the distances involved are very short.

Mr. Barrington-Ward. — But you cannot put two trains over the same hump at the same time. You can, but you would not do it for very long.

Mr. Dubus. — We are quite agreed about that.

Mr. Barrington-Ward. — I think my question goes a little further. I am doubtful about the necessity of having two hump lines. Your reception roads should be your humping lines. Humping lines and reception lines are the same thing.

Mr. Campbell, *Reporter.* — Might I offer some clarification of what I think Mr. MARCHAND wishes to explain. It is that by providing two lines over the hump, the distance between the reception sidings and the hump is reduced by the elimination of one connection. Furthermore, when a train is being humped, another train can be pushed forward on the other line up to the crest of the hump. Time is thereby saved as when the humping of the first train has been completed, the second train is already standing at the crest of the hump, thus saving time which would otherwise be taken in propelling it forward from the reception sidings.

Instead of one connection following the hump, Mr. MARCHAND's system requires scissors crossings to provide access from the two humping lines to the whole of the sorting sidings.

Mr. Watkins, *Reporter.* —Just one point I want to raise. When we speak of hump lines it is lines over the hump.

Mr. Rostern. — I have not yet followed the necessity for two humping lines, and I should be glad if you could indicate the figure, in number of wagons shunted per 24 hours, when it is considered you should have two hump lines instead of one.

Mr. Marchand. — When there is only a single line to the hump, it is necessary to have an interval of time between two successive train shunts, and this is lost time, in order to bring the second train from the reception siding to the hump line. With the double hump system, each hump line can be used for the marshalling of the whole of the marshalling sidings. It is possible to bring up the second train while the first is being shunted on one of the lines on the second hump lines and begin shunting it as soon as the shunting of the first train is completed. In this way, the marshalling continues without interruption, reducing time lost to the minimum.

Mr. Barrington-Ward. — I appreciate what is required now, and, therefore, I will make no further point. The misunderstanding is we have looked at the word « humping » as « reception ». I quite see what you mean now. It is clear what is meant. Agreed. May I suggest instead of « double hump lines » to say « two-lines over the hump »?

Mr. Riggio, *Italian State Railways* (in French). — I think it might also be pointed out that with two hump lines the maintenance of the hump line is facilitated, as whilst maintenance operations are being carried out on one line, shunting can continue on the other.

Mr. Marchand. — If I might be allowed to say so, there is also a third advantage in favour of two or more hump lines, and that is that it makes it possible to shorten the head of the siding group. In Switzerland, for example, in the Zurich yard, there are if I remember rightly three hump lines, because this makes it possible to shorten the head of the reception group.

This may be a very important point in the case of marshalling yards where the length available is not very great.

The President. — Is the wording therefore agreed under these conditions?

— *The Section agreed the original French text; it being decided to modify the English text accordingly.*

Mr. Dubus. — *Summary 12 :*

12. Subsidiary facilities should be incorporated for holding brake vans, locomotives, for the rapid repairs to vehicles and for re-adjusting displaced loads. These installations should facilitate working, but their existence should not, in any case, constitute a source of slowing down the flow of the sorting and geographical marshalling operations.

Mr. Barrington-Ward. — You talk about « holding » locomotives. I do not like the word « holding » locomotives. Holding brake vans and passing locomotives, or « movement of locomotives » if you like.

Mr. Marchand. — Is it the fact that the engines are kept waiting that upsets you?

Mr. Dubus. — I quite understand Mr. Barrington-Ward wanting to see them on the move all the time!

Mr. Marchand. — We had in mind certain installations provided close to the working sidings to take the locomotives for the short periods of time they have to wait to be put at the head of the trains.

It is certainly not always possible to bring the locomotives directly from the sheds to the trains ready to leave; sometimes it is necessary to have a siding where they can wait for a few minutes.

Mr. Barrington-Ward. — I don't mind one or two minutes, but not one or two hours.

The President—The end of the summary agrees with Mr. Barrington-Ward's idea, since it states that such installations should not slow down the flow of the operations.

Mr. Barrington-Ward. — I agree.

The President. — Is everyone agreed?

— *Summary 12 was adopted with the original French text, and the English text was slightly revised.*

Mr. Dubus. — This brings us to the chapter :

Construction (layouts, levels, profiles).

Summary 13 :

13. It is recommended that the heads of siding groups should be very compact, adopt-

ing for the layout curves of minimum radius compatible with free movement of locomotives and vehicles.

It is advisable to use for this purpose specially designed permanent way, particularly short symmetrical two-way leads.

The President. — Has anyone any comment to make upon this summary?

— *Adopted without comment.*

Mr. Dubus. — *Summary 14 :*

14. It is desirable that in the body of the groups the sidings should be of straight alignment; the distance between sidings is determined so as to ensure the safety of staff working in the spaces between them.

The President. — No remarks?

— *Adopted.*

Mr. Dubus. — *Summary 15 :*

15. Considerations of economy in installation and maintenance generally justify the use of recovered serviceable rails in the body of the siding groups and new rails of the type standard for main lines in the heads of the groups. In order to reduce the number of joints, rails in the body of the sidings are sometimes welded.

The President. — Are we agreed about this wording?

— *Adopted without comment.*

Mr. Dubus. — *Summary 16 :*

16. Ballast, the nature of which depends upon local or other sources of supply, is generally placed on an underbed of permeable material. When the nature of the group necessitates it, a drainage system ensures the removal of surface water.

In track circuited areas, particular attention should be paid to ballast and drainage.

The President. — No remarks?

— *Adopted.*

Mr. Dubus. — *Summary 17 :*

17. The reception group is constructed on a fairly level gradient, a short rising gradient approaching the hump being provided in order to permit the uncoupling of vehicles.

It is possible, in order to avoid earthworks, to allow an appreciable gradient between the reception group and the hump without however exceeding the capacity of the locomotives employed for hump shunting.

Mr. Parkhouse, *British Railways.* — I think the wording of the second paragraph would be clearer if it read — « It is possible, in order to avoid earthworks, to allow an appreciable gradient between the reception group and the hump, provided that the capacity of the locomotives employed for hump shunting is not exceeded. »

Mr. Campbell. — I would like to suggest an amendement to the English translation. Instead of the word « avoid » in the first line, second paragraph, the word « reduce » to be substituted.

Mr. Dubus. — We should therefore say: « It is possible, in order to *reduce* earthworks... » and in the French : « Il est possible pour *réduire* les travaux de remblaiement... ».

The President. — Are we agreed about this summary, the text of which will be amended in the case of the second paragraph, as follows :

« 17. The reception group is constructed on a fairly level gradient, a short rising gradient approaching the hump being

provided in order to permit the uncoupling of vehicles.

« It is possible, in order to *reduce* earthworks, to allow an appreciable gradient between the reception group and the hump without however exceeding the capacity of the locomotives employed for hump shunting. »

— *Adopted.*

Mr. Dubus. — *Summary 18 :*

18. The relative levels of the hump and the sorting groups depend upon the drop necessary to ensure under all conditions the separation of vehicles by gravity.

The President. — Does this summary call for any remarks?

— *Adopted without comment.*

Mr. Dubus. — *Summary 19 :*

19. In order to ensure rapid separation of cuts, the radius of the vertical curve of the hump should be small; further the profile between the hump and the head of the sorting group should be hollow and should include a steep initial gradient.

After this gradient, the profile should be such as to ensure in all instances adequate spacing of vehicles up to the braking zone. The brakes are established on a falling gradient in order to liberate easily vehicles which may have been stopped there.

The President. — Agreed?

— *Adopted without comment.*

Mr. Dubus. — *Summary 20 :*

20. The switching area beyond the rail-brakes should be on the level or on a slightly falling gradient — the gradient being then sufficiently reduced to prevent acceleration of good running vehicles.

Such a profile may permit, with experienced brake operators, of increasing the rate of shunting because it is necessary that the vehicles should have an appreciable velocity at the outlet from the brakes, with the object of increasing the distance between successive cuts, thus reducing the risk of overtaking.

Mr. Rostern. — I would like to suggest the deletion of the words « on the level », and leave in « on a slightly falling gradient ».

Mr. Marchand. — I must make it clear that in this case we are dealing with various different techniques. Certain Administrations, such as Switzerland and Germany, which I believe were the pioneers as regards the modernisation of railway marshalling yard technique have the switching area on the level below the brakes.

In Italy and France, certain marshalling yards are on the level and others on a falling gradient. On the other hand, in all the English and American marshalling yards the switching area below the brakes is on a slightly falling gradient.

I should also stress the fact that all Administrations are agreed that no wagon should gather speed after passing the brakes, and consequently the falling gradient must not exceed the slope corresponding to the running resistance of the freest rolling wagons. This is what Mr. Rostern means by requiring a maximum falling gradient, i. e. a slight falling gradient, but we can remain satisfied with something less and even with level track. Certain theorists have even recommended a rising gradient after the brakes.

Those in favour of a falling gradient point out that if by accident a wagon

stops below the brakes, it is easier to push it on. Those in favour of the level stress the fact that this forces the brakesmen to let the wagons pass the brakes at a slightly higher speed since they have to overcome more resistance and this increase in the speed favours the output; the layout of the area below the brakes dictates the output of the yard; this is where wagons may overtake each other, the risk of this is the lesser the greater the speed at which they are running. This is why in theory it is of value to have it on the level. On the other hand, it must be recognised that the work of the brakesmen is rather more difficult in this case, as an error in judgment on their part means a wagon will stop too soon and it will be harder to push it on.

Well, that is the position. I think the level is the best, and makes it possible to obtain a higher marshalling output, with experienced brakesmen.

The President. — There are not merely two solutions, but actually three, since you can have a falling gradient, a level section and a rising gradient, though the report only considers the cases of the falling gradient and the level; consequently it is very cautious. On the other hand, as far as the level is concerned, I would like to point out that the wording used in the report is the following : « The profile on the level *may permit...* » and not « *permits* ». The special report also notes that very experienced brakesmen are necessary. · Consequently, you will appreciate how cautiously the second paragraph deals with this question of the level!

Under these conditions, would not Mr. ROSTERN agree?

Mr. Parkhouse. — I think the English delegation feel that there should be a falling gradient on the hump, because in England we still have wagons which are called « slow » wagons, lubricated with grease instead of with oil, and that makes us feel we should have a falling gradient rather than level, and certainly not rising, because a certain proportion of wagons in England are slow running, or bad rolling wagons, because of the type of lubrication.

Mr. Watkins. — I would like to say that Mr. MARCHAND, Mr. CAMPBELL, and I had difficulty in reconciling this point, and I think as it is shown now it leaves it open, but feel that a slightly falling gradient after coming out of the brakes is the best.

The President. — I think we might satisfy the representatives of the British Railways by making a slight alteration to the text. We could say : « The profile on a *falling gradient* or on the level... » or else « ... on a *slightly falling gradient* or on the level... ».

Mr. Marchand. — The gradients in question are very little; they are 5 mm/m (5‰) at most.

The President. — Further on the summary develops the idea of the level, which gives this a certain importance. Are you agreed that the text of the first paragraph should be modified in this sense, saying : « The switching area beyond the brakes should be on a *slightly falling gradient or on the level...* ».

Mr. Goursat, *French National Railways* (in French). — I would like to add a

word which I think will fall in with the ideas of the British delegates. In my opinion the wording of the first paragraph might be altered as follows : « The switching area beyond the brakes should be on a *slightly falling gradient or on the level*, the gradient then being, *in the first case*, sufficiently reduced... ».

The President. — Will you approve the wording modified in this way :

« 20. The switching area beyond the railbrakes should be on *a slightly falling gradient or on the level* — the gradient being then, *in the first case*, sufficiently reduced to prevent acceleration of good running vehicles.

« A level profile may permit, with experienced brake operators, of increasing the rate of shunting because it is necessary that the vehicles should have an appreciable velocity at the outlet from the brakes, with the object of increasing the distance between successive cuts, thus reducing the risk of overtaking. »

— *Adopted.*

Mr. Dubus. — *Summary 21 :*

21. It is recommended that the longitudinal profile of the sorting group should be hollowed — the ends presenting suitable gradients intended to facilitate the running of vehicles without risk of inopportune acceleration.

Steeper gradients should be provided on the outer sidings in order to compensate for curve resistance — the cross profile being thus slightly cambered.

Mr. Barrington-Ward. — I suggest that the word « hollowed » should be clarified by adding the word « slightly » hollowed. What you require is a saucer shape, but if you have it too hollow there is great danger of damaging the wagons.

Mr. Dubus. — The French text would have to be altered.

Mr. Goursat. — If I may be permitted to interrupt a second time, I would like the wording of the first paragraph (French text) to state : « It is recommended that the longitudinal profile of the sorting group should have a *slightly falling gradient* with a hollowed out form... » whilst the second paragraph remains unchanged.

The President. — The English translation would therefore read : *slightly hollowed? (Agreed.)* And the text would be as follows :

« 21. It is recommended that the longitudinal profile of the sorting group should be slightly hollowed — the ends presenting suitable gradients intended to facilitate the running of vehicles without risk of inopportune acceleration.

« Steeper gradients should be provided on the outer sidings in order to compensate for curve resistance — the cross profile being thus slightly cambered. »

— *Adopted.*

Mr. Dubus. — We now come to the chapter :

Railbrake and switching control.

Summary 22 :

22. The technical development of equipment at large marshalling yards has been characterised in recent years by the increased use of railbrakes.

The design of railbrakes has been improved, in order to facilitate maintenance and

reduce costs correspondingly, and, in certain countries, to overcome difficulties resulting from important variations in the width of wheel tyres.

The President. — No remarks, Gentlemen?

— *Adopted.*

Mr. Dubus. — *Summary 23 :*

23. With the object of keeping down the cost of equipment, it is possible to be satisfied with the installation of one set of railbrakes both for interval and distance braking; each railbrake generally serving a fan of eight sidings.

The President. — Does anyone wish to say anything?

— *Adopted.*

Mr. Dubus. — *Summary 24 :*

24. In installations of this type, the railbrakes can be operated by one man, located at the side at the head of the sorting group; supplementary braking of vehicles which have not been retarded sufficiently by the railbrakes is effected by means of either hand brakes on the vehicles, or by shoes manually placed, or possibly by mechanically operated shoes.

The President. — Does anyone wish to say anything about this text?

— *Adopted without comment.*

Mr. Dubus. — *Summary 25 :*

25. The movement of switches by quick acting motors controlled by track circuit or other equivalent apparatus, facilitates the work of the switch operators; it enables economies in staff to be made and increases the shunting capacity of the yards.

The President.— Are there any remarks?

— *Adopted.*

Mr. Dubus. — *Summary 26 :*

26. Apparatus for the automatic control of switch operation enable the rate of shunting to be increased. Their employment has become general and it has even been extended to yards not equipped with railbrakes.

The President. — Agreed, Gentlemen?

— *Adopted without comment.*

Mr. Dubus. — *Summary 27 :*

27. Automatic switch control must enable the routes of several wagons to be recorded; it can be applied either at the head only of the switching area or throughout. In the latter instance, it is possible to dispense with a switching operator for the sorting sidings provided that devices can be incorporated to avoid incorrect routing of succeeding cuts in the event of one cut overtaking another.

The President. — Has anyone any remark to make?

Mr. Campbell. — I suggest the word « stored » would be better in the English translation than the word « recorded ». We do not use the word « recorded » for this operation.

— *Adopted.*

Mr. Dubus. — *Summary 28 :*

28. Some Administrations include in the automatic switch operation system a storage apparatus which enables successive routes for the different cuts to be stored before the commencement of shunting.

Mr. Marchand. — Mr. President, I would like to add that these Adminis-

trations are not very numerous. Many countries, especially England and France, are not in favour of this arrangement because it implies the preparation of shunting lists, and it has not been proved that this makes any staff savings possible.

Mr. Barrington-Ward. — I would point out it is a little unfortunate that, with all the knowledge of these new yards, we have not been given a balance sheet of the actual cost of the working. On the one hand, you have the first cost of the installation, you have the maintenance, and you have the operation. On the other side of the balance sheet you have the number of wagons shunted per day, which in turn will give you the cost per wagon per day. Is it possible for information to be given of this nature. It will be a guide as to whether you go in for mechanisation or keep to the old ways.

Mr. Marchand. — The information supplied by the Administrations did not make possible any such financial comparison. I might add that when it is question of automatic control of the switches, the estimate of the output must be based on the hourly output rather than the daily output.

I think that with mechanised installations it is possible to shunt about 150 to 200 wagons an hour, whereas without mechanisation it is not generally possible to shunt more than one hundred an hour. Mechanised installations should be used whenever a high hourly output is required.

Mr. Barrington-Ward. — Perhaps my question would be better as a subject for another Congress.

The President. — Are we agreed on this summary?

— Summary 28 was adopted without alteration.

Mr. Dubus. — We now come to the last chapter of the Summaries, entitled : *Auxiliary Equipment* (communications, lighting, buildings).

Summary 29 :

29. Electrically controlled indicators or teletype apparatus enable hump posts to indicate to the brake operator, and eventually to the switch operator, the destination and the nature of each cut; in certain instances such apparatus has avoided the necessity for the preparation of « cut » lists.

Mr. Watkins. — Instead of « eventually » it should, I suggest be « simultaneously », or « at the same time », because by teletype apparatus it goes to the brake operator and the switch operator at the same time on two machines. It should be « simultaneously » and not « eventually ».

Mr. Marchand. — The word « eventually » was used because in some cases there are no switch operators. I agree however that it could be left out.

The President. — We will therefore say :

« 29. Electrically controlled indicators or teletype apparatus enable hump posts to indicate to the brake operator, and *simultaneously* to the switch operator, *where employed*, the destination and the nature of each cut; in certain instances

such apparatus has avoided the necessity for the preparation of « cut » lists. »

— *Adopted.*

Mr. Dubus. — *Summary 30 :*

30. Out-door loud speakers are the most practical and most used means for the transmission of orders to the yard staff; « talk-back » loud-speakers give the same facilities by means of two-way communication.

Liaison between the shunting control points and the yard staff can likewise be effected by means of portable radio apparatus.

The President. — Does anyone want to say anything?

— *Adopted without comment.*

Mr. Dubus. — *Summary 31 :*

31. Communications between shunting control posts and humping locomotives are usually given by mechanical signal or for preference by the illuminated type of signal.

These signals should be repeated as necessary, either in elongated yards or in those yards worked by two locomotives.

At certain modern yards these signals are substituted by apparatus in the driving cab of the shunting locomotives, cab signals, carrier waves, or radio.

Mr. Barrington-Ward. — May I suggest instead of « illuminated » type of signal, a « colour light » signal.

Mr. Watkins. — I would suggest that for humping we do not use colour light signals, for these should only be fitted for running purposes, and for humping you require something which indicates humping both fast and slow.

The President. — Should the text be retained Mr. BARRINGTON-WARD?

Mr. Barrington-Ward. — There is always the question of fog. I still think you want something better than an illuminated type of signal, and you want something which will quickly bring to the notice of the shunting driver when he has to stop.

The President. — This idea is not so explicitely gone into in the summary that we cannot adopt it!

Mr. Marchand. — There is no difficulty in the case of the French text, as the word « lumineux » includes coloured signals as well as the others.

The President. — Is there an English word corresponding to « lumineux » whether the signals are coloured or not?

Mr. Barrington-Ward. — After explanation this leaves it open for anybody to do what he wants.

Mr. Marchand. — I might add that in most countries the signals used are not coloured.

Mr. Campbell. — There are two points on translation. The second paragraph I suggest should read « These signals should be repeated as necessary in elongated yards and in those yards worked by two locomotives ». And one other point; in the last paragraph, the word « substituted » should be deleted, and the word « supplemented » used.

The President. — The summary will therefore be worded as follows :

« 31. Communications between shunt-

ing control posts and humping locomotives are usually given by mechanical signal or for preference by the illuminated type of signal.

« These signals should be repeated as necessary in elongated yards and in those yards worked by two locomotives.

« At certain modern yards these signals are supplemented by apparatus in the driving cab of the shunting locomotives, cab-signals, carrier waves, or radio. »

Are we all agreed about this?

— *Adopted in this slightly modified form.*

Mr. Dubus. — *Summary 32 :*

32. Wireless, which can be « one-way » or preferably « two-way » is developing progressively because it affords more complete and precise inter-communication.

It appears desirable in order to provide for the future, that the Railway Administrations should have the necessary wavelengths allocated to them by the appropriate authorities.

Mr. Barrington-Ward. — Is it right that a driver of a shunting locomotive should be dependent on oral communication. Is it not better for him to have visual communication?

Mr. Rudgard, *British Railways.* — I feel satisfied, Mr. President, that a driver would prefer visual communication every time, so that he does know what he has got to do, and there is no possibility of any mistake.

Mr. Campbell. — I would suggest probably that the point of view is covered by the alteration in translation which I suggested in the previous Conclusion, i.e. « supplemented » in place of « substituted ». It does not mean that wireless will be solely used, but that both wireless and visual signals may be used.

The President. — I am of the same opinion as Mr. Campbell. Is the Meeting agreed that the text should be approved without any changes?

— *Adopted in its original form.*

Mr. Dubus. — *Summary 33 :*

33. The economy of night operation depends upon the character of the illumination provided; this should receive special attention in the zones of intensive shunting or of movements in the zones of centralised switch and brake control posts.

Except in the case of yards subject to frequent fog it is advantageous to use powerful lights fixed at a considerable height; oblique lighting (floodlighting) by projectors enables a reduction to be made in the number of supports and to place them outside the siding groups.

Mr. Barrington-Ward. — The question of « oblique lighting (floodlighting) » is referred to here. Surely the modern method used now is not floodlighting, because it throws shadows. Spot lighting is more appropriate lighting for a yard.

Mr. Marchand. — I do not quite agree. Our enquiries showed that the greater number of Administrations use floodlighting in their new marshalling yards.

This lighting may give cause to tiresome shadows in a small part of the yard, but it is possible to remedy this drawback by using auxiliary local lighting. Floodlighting enables the projectors to be installed outside the groups of sidings and makes the installations very economical.

Mr. Barrington-Ward. — There is also the question of fog. Spot lighting is very much better in fog.

Mr. Marchand. — This is why we stated in the second paragraph of the Summary : « Except in the case of yards subject to frequent fog... ».

Mr. Watkins. — I would like to say that in England we have had experience of both. We have had floodlighting at some yards and have found it not entirely satisfactory, and because of fog we prefer spot lighting, although it is acknowledged that with spot lighting spaces for more posts are required.

Mr. Barrington-Ward. — May I suggest what we have here is a guide to the future, not what we have done in the past.

Mr. Dubus. — Since the Summary states : « Except in the case of yards subject to frequent fogs... ». I think it might be adopted?

Mr. Barrington-Ward. — My point is that, taking into account that reference is made to the number of supports, I would sooner have spaces left with spot lighting than no supports and floodlighting.

Mr. Marchand. — I found that many Administrations had used floodlighting in their installations and found it satisfactory from the operating point of view.

The President. — What does Mr. BARRINGTON-WARD suggest?

Mr. Barrington-Ward. — What I propose is that floodlighting is out of date.

Mr. Marchand. — It is not so according to the replies received from the Administrations. To satisfy the British delegates, I suggest saying : « Many Administrations consider that, except in the case of yards... ».

The President. — Is the wording of Summary 33 with this addition to the second paragraph adopted? *(Agreed.)*

— *Adopted with the following addition to the second paragraph :*

Many Administrations consider that, except in the case of yards subject to frequent fog, it is advantageous to use powerful lights fixed at a considerable height; oblique lighting (floodlighting) by projectors enables a reduction to be made in the number of supports and they can be placed outside the siding groups.

Mr. Dubus. — *Summary 34 :*

34. The control posts for the switches and railbrakes should be sited and arranged in order to ensure the best visibility of the ground; they are generally elevated and provided with large bay windows and awnings.

Mr. Dyer, *British Railways.* — Would it not be desirable to put in this Summary that control posts should have illuminated diagrams of the layout of the yard. It seems to me that this is a supplementary facility which should be provided in every control post.

Mr. Marchand. — I think that these devices are generally used in all marshalling yards as, as soon as track circuits

have been installed, it is necessary to check the occupation of these circuits. This is usually done by means of luminous diagrams, and I think everyone will agree on this point. Is it essential to insist upon it?

Mr. Watkins. — It is the practice at certain new yards in England to have the illuminated diagram on which the lights come up with the successive operation of the track circuits and the argument for this arrangement is that it gives the operator in the tower an indication of how the wagons are running if visibility is not good.

Mr. Dyer. — It is, of course, a general rule that control posts should be sited and arranged for best visibility from the ground. I think, equally, it is a general rule that illuminated diagrams should be provided. If you say it is a general rule the location of control posts should be good, it seems logical to me that you should also put in illuminated diagrams.

Mr. Marchand. — To meet Mr. Dyer's request, I suggest saying : « The control posts for the switches and brakes, *which are always equipped with illuminated diagrams* should be sited and arranged in order to assure the best visibility of the ground; they are generally elevated and provided with large bay windows and awnings ».

The President. — Are we all in agreement about this wording, Gentlemen?

— *Adopted in the form read by* Mr. Marchand.

Mr. Dubus. — *Summary 35 :*

35. Apart from the different buildings which it is an advantage to group, each yard requires a principal administrative and control building which is generally installed at the main centre of operation.

The President. — Does this text call for any remark?

Mr. Marchand. — Mr. President, I would like to call attention to one point.

It says, in this Summary, that « this building is generally installed at the main centre of operation ». Formerly, the main centre of operation of a marshalling yard was the shunting groups, which was the busiest part, but I think that now with the new installations the shunting groups should work alone with a reduced supervisory staff, and the most difficult operations take place on the contrary in the formation sidings which thus become the main centre of operation.

It seems to me — I am speaking from the personal point of view — that the main building in modern marshalling yards should be by the formation sidings.

Mr. Barrington-Ward. — I do not like « control » building. Control is our system of operation of the railway generally, and I would like the words « principal administration and essential supervisory building », or « building for central supervision ». Anyway, the word « control » should be replaced.

The President. — With this reservation in the case of the English text, is this Summary approved by the Meeting?

— *Adopted without modification.*

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VARIOUS

The President. — As we have finished discussing the Summaries for Question III which were on the aggenda for this Meeting, and still have some time remaining this morning, perhaps you would like to go into various details in connection with the questions dealt with by the Congress?

If you agree, I will let anyone who wants to raise any such points take the floor. *(Agreed.)*

Signalling.

Mr. Marchand. — Mr. PRESIDENT, I would like to allude to a point which was raised just now in connection with the signalling. It is stated in effect that luminous shunting signals are completed and not replaced by radio equipment. It is certain that so far such equipment is not sufficiently dependable for it to be used alone, but I think we shall soon arrive at the stage where it is sufficiently regular in operation; when this happens it will be only logical to suppress luminous shunting signals in order to avoid duplicating the installations.

The President. — I think that radio signals are already very highly developed.

Mr. Marchand. — They have been developed but they have not yet been sufficiently perfected to be entirely dependable.

Mr. Rudgard. — Mr. PRESIDENT. If that comes about, would it be desirable to make a record of the visual signal that the driver has had. Is it desirable to have a record of each signal as it is given? Do you understand? The visual signal when you come to that time when all signals are done away with and we rely on signals in the locomotive. Would Mr. MARCHAND agree?

Mr. Marchand. — I think that Mr. RUDGARD in speaking of « record » means a control signal visible to the driver, and not a record?

I consider that it is technically possible to give a « record » of this kind, but its value is a moot point, especially with two-way installations when the driver acknowledge receipt of the signals.

Mr. Dyer. — There are two points of view about engine cab signals. One is the question of reliability of the apparatus and the other, assuming 100 % reliability, is whether the operating department would be satisfied with an indication in the cab of the engine in place of fixed signals.

Apart from the question of cab signalling, using a small colour light signal in the engine cab, there is the question of radio communication. These are two quite distinct things. The operating department might be satisfied, assuming 100 % efficiency, with cab signalling but they might not be satisfied with radio telephone communication. I think we could claim almost 100 % technical efficiency for engine cab signals by the use of coded track circuits, the indications being picked up by apparatus on the engine. One advantage of fixed signals is that they are quite easily repeated back to the Control Tower but it would be a rather complicated and expensive opera-

tion to repeat cab signals to the control tower.

Mr. Watkins. — The view I am going to express is somewhat similar to Mr. Rudgard's. It is very desirable the driver should have in front of him some proper indication of the signal that has been given and that he should not have to rely entirely on the spoken word. He may misunderstand it, or forget it, and time may elapse before an order given is changed. He should have something in front of him showing the last order given.

Mr. Marchand. — Mr. President, I think in the future it will be technically possible to satisfy the different points of view that have just been expressed, that is to say we shall be able to install radio installations by which instructions can be given to the driver either visually or audibly. But should we express a preference for the one or the other at this stage? I do not think so. In the case of the marshalling, the orders given to a switch operator or driver can be given verbally because this is not primarily a question of safety. I say, primarily, in the sense that if the driver misunderstands the order given, material damage can result, but the question of safety does not come into the picture to the same extent as in the case of passenger trains.

To conclude, I think we have discussed this point sufficiently because there are actually two methods, both of which have advantages and drawbacks, which it is impossible to go into to-day.

The President. — I think that if radio installations are used on a greater scale in the future, it will be essential for the driver to have a signal in front of him proving that the radio connection is working properly. Whether the visual or oral system is adopted, it is necessary to make sure that it is working properly and that the order given are understood. I have carried out operating trials myself and I can state that it is necessary to make sure that the connections are good and working properly.

Mr. Barrington-Ward. — Is not the real answer to this question to do away with both the engine and the driver. Some years ago in the neighbourhood of Leipzig I saw a yard where buffers came up behind a train on the reception road and gently worked the whole train over from the control post. I am afraid I do not know how this has developed, and I cannot go and see it now.

Mr. Marchand. — This question was raised at the Madrid Congress, but according to the replies received from the Administrations, we found that this apparatus was not developed; it was merely a question of trials.

Mr. Dyer. — There is a fundamental objection, of course, to relying on telephone communication. With signalling, matters are arranged so that in the event of a failure the result is a danger signal but a failure to transmit a telephone message to stop shunting would be quite unsafe. To overcome this fundamental objection and to give the equivalent to signalling practice it would seem necessary to transmit continuously such a phrase as « keep on shunting » by means of a

record. This would only be interrupted when it was desired to give some other instruction.

Mr. Marchand. — As I stated above, we cannot be sure about it, but I think this exchange of views has been very interesting.

Railbrakes, brakesmen, weighing wagons.

Mr. Marchand. — The special report mentioned the possibility of improvement which may have a certain interest in the future; the reporters considered that it was not opportune to mention these in the proposed summaries which have just been discussed, but I think it would be interesting to hear the opinion of the delegates on these matters.

I will briefly sum up the three points in question :

1. Railbrakes are extremely valuable from the operating point of view, but cannot be greatly extended owing to their high cost. I think all operators would like to have simpler and cheaper railbrakes available. I think this question should be brought to the notice of all the Administrations in order to encourage them to undertake research in this connection.

2. Mechanisation has made it possible to reduce the staff employed in the actual marshalling; it is still necessary to use brakesmen however to stop the wagons by means of hand brakes or shoes. This is a heavy burden from the operating point of view, and the staff employed in these operations are exposed to risks of accident. It would be certainly desirable to improve the technique and reduce the number of brakesmen required by improving the efficiency of the railbrakes. This problem has not yet been solved by the research undertaken.

3. Trials of weighing wagons at the hump have been carried out by certain Administrations in order to reveal under statements of weight and collect the proper rates. It would be interesting to learn whether these trials, which have been carried out in particular in America and Holland, have been found satisfactory.

Mr. Boot, *Netherlands Railways.* — We have gone into this latter point, and are now installing a weighbridge at the Amsterdam marshalling yard. The great difficulty with such a weighbridge is the fact that each wagon must be uncoupled from the other wagons, so that it is necessary to provide a very little hump in front of the main hump. In view of the difficulties encountered, we have asked other countries which have gone into this question to let us know the results obtained.

Another difficulty lies in the speed at which the wagons run over the weighbridge; this speed is of the order of 3-4 km (1.8-2.4 miles)/h. The weighing is correct to approximately 92 to 93 %.

The President. — Has no one any experience of this matter, apart from Holland?

Mr. Marchand. — There are many installations of this type in America, but

unfortunately we have only very brief details about them.

Mr. Boot. — We have tried another system which centralises inspection at the foot of the hump.

Mr. Marchand. — There are no installations in Europe where inspection takes place at the top of the hump, like there are in America. Rather than have inspectors working on the reception sidings, the American Railways put them in observation pits or lookouts, from which they examine the wagons as they pass, and they are in communication with the hump, and divert to repair sidings any defective wagons noticed. There are no such installations in Europe as far as I know.

The President. — Has anyone else anything to say about this point, or any other question?

Gentlemen, we have completed the aggenda set by the Congress for Section I, so there will be no Meeting to-morrow.

— *The Meeting ended at 11.30 a. m.*

DISCUSSION AT THE PLENARY MEETING.

Meeting held on October 4th, 1950.

Dr. Eng. G. di Raimondo, President, in the Chair.
General Secretaries : Mr. P. Ghilain and Dr. Eng. M. Valdivieso.
Assistant General Secretary : Mr. Ch. E. Whitworth.

Mr. Ghilain, *General Secretary.* — We now come to the examination of the Summaries relating to Question III, which were published in the *Daily Journal of the Congress*, No. 6.

— *These Summaries raised no remarks.*

The President. — We will consider the Summaries for Question III as adopted.

SUMMARIES.

General.

« 1. The methods adopted in the « design and construction of marshalling « yards are based on the fundamental « principles laid down at the Congresses « of London (1925) and Madrid (1930); « they aim at increasing efficiency, « reducing costs and enlarging shunting « capacity by the application of « mechanisation » and the planning of « rational lay-outs and profiles.

« 2. Each new scheme presents a « particular problem, from the points of « view of cost of construction and economy in working. It is desirable that « the study of schemes should be « advanced as far as possible by competent staff of the using department « before constructional plans are prepared (commenced).

« 3. The modernisation of existing « yards, often situated in congested « areas, may present difficulties of realisation owing to the want of available « space.

« 4. The construction of new yards « and, eventually, of the necessary locomotive depots, involves the finding of « suitable sites from the point of view « of superficial area and contour; when « the sites selected are remote from « populated areas, it is necessary to « consider means of transport, and « housing accommodation for staff.

« 5. Except where special cases or « local circumstances render all other « solution impracticable, the construction of double yards, comprising two « yards, side by side, each dealing with « an opposing flow of traffic, is justified only when the number of vehicles « to be dealt with exceeds the capacity « of a single hump yard.

« 6. Yards on the gravitation prin- « ciple, wholly or partially, are only

« constructed where a suitable profile « exists or can be made.

Location of groups of sidings and connecting lines.

« 7. In addition to reception and sort- « ing groups, which are usually laid out « in sequence, large yards should have « separate marshalling and departure « groups, also storage and lay-by faci- « lities as necessary.

« From the point of view of operat- « ing convenience, and expeditious « transfer movements of vehicles, it is « recommended that the following be « provided :

« departure groups in continuation of « the sorting group;

« marshalling group and recess lines « at the sides of the sorting group.

« 8. The number of sidings in the dif- « ferent groups and their effective length « are decided by the department res- « ponsible for operating, according to « service requirements, taking into con- « sideration future developments and « having regard to the space available.

« 9. The arrangement of communi- « cating and connecting lines, and the « siting of the leads of the groups of « sidings should be studied with the « object of facilitating the movement of « trains and locomotives so as to reduce « to the absolute minimum interference « between trains, locomotives and shunt- « ing operations. In these circumstances « constructional works should be under- « taken in order to eliminate the more « restrictive cross-movements.

« 10. The risk of interference be- « tween shunting operations and trains « can be appreciably reduced by the « provision of independent facilities; at « large yards the provision of direction « reversing loops or equivalent facilities « permits, in conjunction with the use of « departure groups, of one way working « which facilitates operation.

« 11. The layout at the heads of the « groups of sidings should be as simple « as possible in order to reduce the « length of shunt.

« The provision of two lines over the « hump at the same level enables an « appreciable reduction to be made in « the length of the head of the recep- « tion lines nearest to the hump; it also « affords the possibility of more con- « tinuous shunting when two humping « locomotives are employed.

« On the other hand humping lines « at different levels (winter and summer) « have the disadvantage of lengthening « the layout and the length of shunt. « Moreover they are unnecessary when « the yard is equipped with railbrakes.

« 12. Subsidiary facilities should be « incorporated for accommodating brake « vans, locomotives, for the rapid « repairs to vehicles and for re-adjusting « displaced loads. These installations « should facilitate working, but their « existence should not, in any case, con- « stitute a source of slowing down the « flow of the sorting and geographical « marshalling operations.

Construction (Layouts, levels, profiles).

« 13. It is recommended that the « heads of siding groups should be very

« compact, adopting for the layout curves of minimum radius compatible with free movement of locomotives and vehicles.

« It is advisable to use for this purpose specially designed permanent way, particularly short symmetrical two-way leads.

« 14. It is desirable that in the body of the groups the sidings should be of straight alignment; the distance between sidings is determined so as to ensure the safety of staff working in the spaces between them.

« 15. Considerations of economy in installation and maintenance generally justify the use of recovered serviceable rails in the body of the siding groups and new rails of the type standard for main lines in the heads of the groups. In order to reduce the number of joints, rails in the body of the sidings are sometimes welded.

« 16. Ballast, the nature of which depends upon local or other sources of supply, is generally placed on an underbed of permeable material. When the nature of the group necessitates it, a drainage system ensures the removal of surface water.

« In track circuited areas, particular attention should be paid to ballast and drainage.

« 17. The reception group is constructed on a fairly level gradient, a short rising gradient approaching the hump being provided in order to permit the uncoupling of vehicles.

« It is possible, in order to reduce earthworks, to allow an appreciable gradient between the reception group and the hump without however exceeding the capacity of the locomotives employed for hump shunting.

« 18. The relative levels of the hump and the sorting groups depend upon the drop necessary to ensure under all conditions the separation of vehicles by gravity.

« 19. In order to ensure rapid separation of cuts, the radius of the vertical curve of the hump should be small; further the profile between the hump and the head of the sorting group should be hollow and should include a steep initial gradient.

« After this gradient, the profile should be such as to ensure in all instances adequate spacing of vehicles up to the braking zone. The brakes are established on a falling gradient in order to liberate easily vehicles which may have been stopped there.

« 20. The switching area beyond the railbrakes should be on a slightly falling gradient or on the level — the gradient being then, in the first case, sufficiently reduced to prevent acceleration of good running vehicles.

« A level profile may permit, with experienced brake operators, of increasing the rate of shunting because it is necessary that the vehicles should have an appreciable velocity at the outlet from the brakes, with the object of increasing the distance between successive cuts, thus reducing the risk of overtaking.

« 21. It is recommended that the longitudinal profile of the sorting

« group should be slightly hollowed — « the ends presenting suitable gradients « intended to facilitate the running of « vehicles without risk of inopportune « acceleration.

« Steeper gradients should be pro- « vided on the outer sidings in order to « compensate for curve resistance — the « cross profile being thus slightly cam- « bered.

Railbrake and switching control.

« 22. The technical development of « equipment at large marshalling yards « has been characterised in recent years « by the increased use of railbrakes.

« The design of railbrakes has been « improved, in order to facilitate main- « tenance and reduce costs correspond- « ingly, and, in certain countries, to « overcome difficulties resulting from « important variations in the width of « wheel tyres.

« 23. With the object of keeping « down the cost of equipment, it is pos- « sible to be satisfied with the installa- « tion of one set of railbrakes both for « interval and distance braking; each « railbrake generally serving a fan of « eight sidings.

« 24. In installations of this type, the « railbrakes can be operated by one « man, located at the side at the head « of the sorting group; supplementary « braking of vehicles which have not « been retarded sufficiently by the rail- « brakes is effected by means of either « hand brakes on the vehicles, or by « shoes manually placed, or possibly by « mechanically operated shoes.

« 25. The movement of switches by « quick acting motors controlled by « track circuit or other equivalent appa- « ratus, facilitates the work of the switch « operators; it enables economies in staff « to be made and increases the shunting « capacity of the yards.

« 26. Apparatus for the automatic « control of switch operation enable the « rate of shunting to be increased. « Their employment has become general « and it has even been extended to yards « not equipped with railbrakes.

« 27. Automatic switch control must « enable the routes of several wagons « to be stored; it can be applied either « at the head only of the switching area « or throughout. In the latter instance, « it is possible to dispense with a switch- « ing operator for the sorting sidings « provided that devices can be incor- « porated to avoid incorrect routing of « succeeding cuts in the event of one cut « overtaking another.

« 28. Some Administrations include « in the automatic switch operating sys- « tem a storage apparatus which enables « successive routes for the different cuts « to be stored before the commencement « of shunting.

Auxiliary equipment (communications, lighting, buildings).

« 29. Electrically controlled indica- « tors or teletype apparatus enable « hump posts to indicate to the brake « operator, and simultaneously to the « switch operator, where employed, the « destination and the nature of each cut; « in certain instances such apparatus

« has avoided the necessity for the preparation of « cut » lists.

« 30. Out-door loud speakers are the most practical and most used means for the transmission of orders to the yard staff; « talk-back » loud-speakers give the same facilities by means of two-way communication.

« Liaison between the shunting control points and the yard staff can likewise be effected by means or portable radio apparatus.

« 31. Communications between shunting control posts and humping locomotives are usually given by mechanical signal or for preference by the illuminated type of signal.

« These signals should be repeated as necessary in elongated yards and in those yards worked by two locomotives.

« At certain modern yards these signals are supplemented by apparatus in the driving cab of the shunting locomotives, cab-signals, carrier waves, or radio.

« 32. Wireless, which can be « one-way » or preferably « two-way » is developing progressively because it affords more complete and precise intercommunication.

« It appears desirable in order to provide for the future, that the Railway Administrations should have the necessary wavelengths allocated to them by the appropriate authorities.

« 33. The economy of night operation depends upon the character of the illumination provided; this should receive special attention in the zones of intensive shunting or of movements in the zones of centralised switch and brake control posts.

« Many administrations consider that, except in the case of yards subject to frequent fog, it is advantageous to use powerful lights fixed at a considerable height; oblique lighting (flood-lighting) by projectors enables a reduction to be made in the number of supports and to place them outside the siding groups.

« 34. The control posts for the switches and railbrakes, which are always equipped with illuminated diagrams, should be sited and arranged in order to ensure the best visibility of the ground; they are generally elevated and provided with large bay windows and awnings.

« 35. Apart from the different buildings which it is an advantage to group, each yard requires a principal administrative and supervisory building which is generally installed at the main centre of operation. »

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DIRECTION GÉNÉRALE de la D. B. — Le **nouveau service de grands containers** des Chemins de fer allemands. (3 000 mots & fig.)

Electricité. (Paris.)

1950 **621** .335 (44)
Electricité, janvier, p. 9.
DEVAUD (L.). — Les **nouvelles locomotives électriques à grande vitesse 2D2** 9101 à 9135. (2 500 mots & fig.)

1950 **621** .33 (73)
Electricité, mai, p. 129; juin, p. 159.
GÉNIN (G.). — Le développement de la **traction électrique** aux U. S. A. (6 000 mots & fig.)

1950 **625** .233
Electricité, juillet-août, p. 181.
ROGER (J.). — **L'éclairage par fluorescence des voitures de chemins de fer** et des véhicules de transport en commun. (5 000 mots & fig.)

1950 **62** (01 & **669**
Electricité, décembre, p. 304.
GOERENS (P.). — **Jauges de contraintes à fil résistant.** (4 000 mots & fig.)

L'Industrie des Voies ferrées et des Transports automobiles. (Paris.)

1950 **621** .338 : **625** .42 (44)
L'Industrie des Voies ferr. et des Transp. automobiles, mars, p. 540.
Les **nouvelles rames articulées** du « Métro » de Paris. (1 500 mots & fig.)

1950 **625** .2 & **669** .71
L'Industrie des Voies ferr. et des Transp. automobiles, mai, p. 569.
REINHOLD (J.). — **L'aluminium et ses alliages dans la construction du matériel de chemin de fer.** (6 000 mots & fig.)

1950 **62** (01 & **691**
L'Industrie des Voies ferr. et des Transp. automobiles, octobre, p. 636.
JOUR (R.). — **Résistance des poteaux en béton armé** des lignes aériennes de contact à l'action de l'eau de pluie. (4 000 mots & fig.)

1950 **625** .213
L'Industrie des Voies ferr. et des Transp. automobiles, décembre, p. 668.
SANTOS SARALEGUI (M. M.). — Les avantages du **système de suspension du train « Talgo »**. (2 500 mots & fig.)

L'Ossature métallique. (Bruxelles.)

1950 **721** .1
L'Ossature métallique, septembre, p. 396.
VERDEYEN (J.). — **Possibilités d'application des palplanches et des pieux métalliques aux constructions urbaines.** (4 000 mots & fig.)

1950 **62** (01 & **669** .1
L'Ossature métallique, septembre, p. 428.
MAGNEL (G.). — **L'acier précomprimé.** Nouvelles considérations. (3 000 mots & fig.)

Rail et Route. (Paris.)

1950 **656** .1 (481)
Rail et Route, mai, p. 20.
Les **services routiers** des Chemins de fer norvégiens. (1 500 mots & fig.)

1950 **621** .33
Rail et Route, juillet, p. 3.
CHARLET (J.). — **L'électrification** des Chemins de
aux Etats-Unis. (4 000 mots & fig.)

1950 **656** .21
Rail et Route, juin, p. 1; juillet, p. 9; août, p. 4; tembre, p. 10; octobre, p. 8.
RUBINSTEIN (J.). — Les **gares de triage moder**
(8 000 mots & fig.)

1950 **621** .138 .1
Rail et Route, août, p. 1.
BOSC (A.). — Un **dépôt moderne de locomoti**
Marseille-Blancarde. (2 000 mots & fig.)

1950 **385** .517 .6
Rail et Route, août, p. 9.
MICHAUD (Dr. J.). — Le **service médical** de la S
C. F. (2 500 mots & fig.)

1950 **621** .331
Rail et Route, septembre, p. 5; octobre, p. 5.
GARREAU (M.). — Les **sous-stations de tracti**
courant continu 1500 V. Leur évolution technique. (8
mots & fig.)

1950 **656** .225 & **656**
Rail et Route, octobre, p. 13.
Les **remorques porte-wagons.** (1 200 mots & fig.)

Revue de l'Association française des Amis des Chemins de fer. (Paris.)

1949 **621** .335
Revue de l'Assoc. franç. des Amis des ch. de fer, ju août, p. 73.
GACHE (A.) & CAIRE (D.). — La **première**
motive électrique à grande vitesse et à adhérence t
de la S. N. C. F. La CC 7001-Alsthom. (3 000 m
tableaux & fig.)

1949 **621** .13
Revue de l'Assoc. franç. des Amis des ch. de fer, ju août, p. 79.
VILAIN (L.). — Le travail en service courant o
essais de **locomotives à marchandises et machines-te**
françaises construites de 1924 à 1938. (4 000 m
tableaux & fig.)

1949-1951 **385** (09
Revue de l'Assoc. franç. des Amis des ch. de fer, tembre-octobre, p. 97; novembre-décembre, p. janvier-février, p. 6.
Les **Chemins de fer Italiens** devant les problème
l'après-guerre. (20 000 mots, tableaux & fig.)

1949 **656** .222 .1
Revue de l'Assoc. franç. des Amis des ch. de fer, sep bre-octobre, p. 107.
Baron VUILLET & CAIRE (D.). — Renseignem
sur les **parcours à grande vitesse des trains de voya**
aux Etats-Unis et au Canada. (500 mots et tableau

949 **625** .232 (493)
ue de l'Assoc. franç. des Amis des ch. de fer, sep-tembre-octobre, p. 114.
es nouvelles voitures-lits de 1re, 2e et 3 classe de la mpagnie Internationale des Wagons-Lits et des nds Express Européens. (500 mots & fig.)

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ue Générale des Chemins de fer. (Paris.)

950 **625** .244 (44)
ue générale des Chemins de fer, mars, p. 93.
ARIDAN. — Un nouveau **groupe mobile de préréfri-tion.** (3 500 mots & fig.)

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950 **621** .87 (44)
ue générale des Chemins de fer, mars, p. 99.
OURGUELLE & DUPLAT. — Les **grues de rele-** de 85 tonnes de la S. N. C. F. (3 000 mots, tableaux g.)

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950 **625** .2 (0
ue générale des Chemins de fer, mars, p. 107.
ASPARD. — La **résistance du matériel roulant** aux rts mécaniques. (8 000 mots & fig.)

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950 **621** .332 (44)
ue générale des Chemins de fer, mars, p. 119.
ERNARD. — La **table de calcul électrique** à courant tinu de la S. N. C. F. (4 000 mots & fig.)

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950 **656** .212 .6
ue générale des Chemins de fer, mars, p. 127.
OUSSE. — **Principaux matériels unifiés de manuten-électrique.** (1 000 mots & fig.)

Revue Générale de Mécanique. (Paris.)

949 **62** (01
ue générale de Mécanique, juillet, p. 289.
EDDE D'ENTREMONT (B.). — Le **cercle de Mohr** es applications aux matériaux usuels. (6 000 mots g.)

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949 **621**
ue générale de Mécanique, août, p. 313.
IÉRIEL-BUSSY (H.). — Le **Congrès International Normalisation** à Paris. (2 000 mots & fig.)

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949 **621** .438
ue générale de Mécanique, octobre, p. 411.
ENIGER (R.). — Moyens d'augmenter la résistance températures élevées des éléments de **turbines à gaz.** 00 mots & fig.)

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950 **62** (01 & 669
ue générale de Mécanique, juillet, p. 251.
ORLET (E.). — Les notions fondamentales, les nées expérimentales et les travaux récents concer- le **fluage.** (5 000 mots & fig.)

1950 **691**
Revue générale de Mécanique, juillet, p. 271.
BALLAY. — La **lutte contre la corrosion et l'usure des métaux** par les traitements de surface.
La galvanisation.
HEDDE (W. F.). — La métallisation au pistolet. (9 000 mots & fig.)

Revue universelle des Mines. (Liège.)

1949 **62** (01
Revue universelle des Mines, février, p. 41.
MASSONNET (Ch.). — Un **appareil nouveau pour étudier la sollicitation des pièces planes** et des plaques fléchies de forme quelconque. (6 000 mots & fig.)

1949 **625** .1 (493)
Revue universelle des Mines, mars, p. 88.
MARCHAL (A.). — **Aménagements ferroviaires projetés** dans la Région liégeoise. (6 000 mots & fig.)

1949 **621** .133 .1
Revue universelle des Mines, mai, p. 150.
VÉRON. — Sur un **diagramme de combustion** applicable à tous les combustibles. (12 000 mots & fig.)

1949 **62** (01
Revue universelle des Mines, octobre, p. 329.
PIRARD (A.). — Sur un **procédé photoélectrique permettant la détermination des tensions dans des plans successifs.** (5 000 mots & fig.)

1949 **691**
Revue universelle des Mines, décembre, p. 421.
CAMPUS (F.). — Le **béton précontraint.** (Principes et propriétés, expériences, premières réalisations). (7 000 mots & fig.)

Traction électrique. (Paris.)

1949 **621** .335 (492)
Traction électrique, janvier-février, p. 3.
Locomotives électriques de 4 500 CV pour service mixte aux Chemins de fer Néerlandais. (1 000 mots & fig.)

1949 **621** .33 (65) & **621** .431 .72 (65)
Traction électrique, janvier-février, p. 4.
Traction électrique et traction diesel-électrique sur les Chemins de fer Algériens. (2 000 mots.)

In German.

Elektrische Bahnen. (München.)

1950 **621** .33
Elektrische Bahnen, August, S. 189.
PUTZ (R.). — Über berechnete und gemessene **Streckenwiderstände und Gleisströme** bei 50 Hz. (2 000 Wörter & Tabellen.)

1950 **621** .135 .2
Elektrische Bahnen, August, S. 192.
ABLASSMAYER (H.). — **Spurkranz- und Schienenschmierung.** (4 000 Wörter, Tabellen & Abb.)

1950 **621** .131 .1 & **625** .14
Elektrische Bahnen, September, S. 201.
CURTIUS (E. W.) & KNIFFLER (A.). — Neue Erkenntnisse über die **Haftung zwischen Treibrad und Schiene.** (12 000 Wörter & Abb.)

1950 **621** .335
Elektrische Bahnen, September, S. 211.
v. ONDARZA (M.). — Die Hochspannungssteuerung bei **Wechselstrom- Triebfahrzeugen.** (7 000 Wörter & Abb.)

1950 **621** .332
Elektrische Bahnen, Oktober, S. 225; November, S. 249.
KETTNER (K.). — Systeme, Energieverhältnisse und Ausführungsformen der **unmittelbaren Umrichter für Drehstrom 50 Hz-Einphasenstrom 16 2/3 Hz.** (12 000 Wörter & Abb.)

1950 **621** .332
Elektrische Bahnen, Oktober, S. 234.
NIBLER (H.). — **Dynamisches Verhalten von Fahrleitung und Stromabnehmer** bei elektrischen Hauptbahnen. (7 000 Wörter & Abb.)

Glasers Annalen. (Berlin.)

1950 **625** .245 (43)
Glasers Annalen, April, S. 59.
TRÜMPER (K.). — **Hydraulisch betätigter Zweiseitenkipper** für hohe Nutzlasten. (3 000 Wörter & Abb.)

1950 **621** .431 .72
Glasers Annalen, April, S. 64.
ECKHARDT (W.). — Eine **neue Diesellokomotiv-Bauart mit hydraulischem Getriebe.** (1 500 Wörter & Abb.)

1950 **621** .335
Glasers Annalen, Mai, S. 81.
KNIFFLER (A.). — Die **neuere Entwicklung im Bau elektrischer Lokomotiven und Triebwagen.** (3 700 Wörter & Abb.)

1950 **621** .33
Glasers Annalen, Mai, S. 86.
FRITSCHE (R.). — **Bahnelektrisierung mit 16 2/3 oder 50 Hertz?** (8 000 Wörter.)

1950 **625** .2 (01
Glasers Annalen, Mai, S. 91; Juni, S. 97; August, S. 146.
SPERLING (E.). — Die **Laufeigenschaften der Eisenbahnwagen waagerecht quer zum Gleis.** (12 000 Wörter & Abb.)

1950 **621** .134 .1
Glasers Annalen, Juli, S. 122.
MARSCHALL (A.). — **Zur Frage des Achsantriebes von Dampflokomotiven.** (4 000 Wörter & Abb.)

1950 **656** .225 (43) & **656** .261 (
Glasers Annalen, September, S. 158.
PFAHL (K.). — Der **Grossbehälter-** ein Versuch
Modernisierung des Güterverkehrs bei der Bundesba
(2 200 Wörter & Abb.)

In English.

The Engineer. (London.)

1950 **625** .28 (
The Engineer, January 13, p. 51.
Some work on British Railways in 1949 *(continua and end).* (2 400 words & fig.)

1950 **621** .
The Engineer, January 13, p. 68; January 20, p.
January 27, p. 124; February 3, p. 157.
Gas turbines in 1949. (15 000 words & fig.)

1950 **621** .134
The Engineer, February 10, p. 171; February 17, p. 2
TUPLIN (W. A.). — **Locomotive cylinder pow**
(6 800 words & fig.)

1950 **621** .431 .72 (
The Engineer, February 10, p. 174.
Diesel-electric shunting locomotive. (1 000 words &

1950 **621** .138 .3 (
The Engineer, February 17, p. 221.
Repair of locomotive plate frames by welding. (2
words & fig.)

1950 **624** .62 (
The Engineer, February 24, p. 234.
An aluminium highway bridge. (1 500 words &

1950 **621** .33 (
The Engineer, February 24, p. 248.
The Manchester-Sheffield-Wath electrification sche
(5 000 words & fig.)

1950 **621** .33
The Engineer, March 24, p. 359; March 31, p. 402.
COCK (C. M.). — **Railway electrification in G**
Britain. (6 000 words & tables.)

1950 **621** .33
The Engineer, March 24, p. 366.
Electric railway traction. (5 000 words & fig.)

1950 **621** .335
The Engineer, April 7, p. 432.
A Diesel-electric locomotive for South America.
words & fig.)

1950 **621** .438
The Engineer, May 19, p. 608; May, 26 p. 626.
British Railways gas turbine locomotive No. 18
(8 900 words & fig.)

950 **656** .254 (42)
e Engineer, June 9, p. 673; June 16, p. 700; June 23, p. 727.
New Eastern Region signalling. (9 000 words & fig.)

950 **621** .431 .72 (42)
e Engineer, July 21, p. 73.
An 0-6-0 Diesel locomotive on the Southern Region. 0 words & fig.)

950 **621** .132 .1 (73)
e Engineer, August 11, p. 143; August 18, p. 173; August 25, p. 196; September 1, p. 225.
TUPLIN (W. A.). — **Some American locomotives and ir running.** (18 000 words, tables & fig.)

950 **621** .335
e Engineer, August 18, p. 177.
Mixed traffic locomotive for Estoril Railway. (3 000 rds & fig.)

Engineering. (London.)

950 **721** .9
gineering, January 13, p. 55.
MAY (D. H.). — The **Magnel-Blaton system for stressing concrete.** (1 200 words & fig.)

950 **621** .132 .6 (42)
gineering, January 20, p. 76.
Light 0-6-0 Pannier-tank locomotive, Western Region, tish Railways. (400 words & fig.)

950 **721** .9
gineering, January 20, p. 80.
COLLINS (A. R.). — The **principles of making high-ength concrete.** (2 000 words & fig.)

950 **621** .132 .1 (94)
gineering, January 27, p. 104.
-6-2 locomotives fot the Western Australia Govern-nt Railways. (1 200 words & fig.)

950 **621** .392
gineering, February 17, p. 177; March 3, p. 251.
Repair of locomotive plate frames by metallic arc ding. (4 000 words & fig.)

950 **621** .33 (42)
gineering, February 24, p. 205.
Manchester - Sheffield - Wath railway electrification. 300 words & fig.)

950 **656** .212 .6 (42)
gineering, March 10, p. 280.
LUND (G.). — **Railway breakdown and re-railing ipment.** (3 400 words & fig.)

950 **621** .132 .1 (68)
gineering, March 24, p. 313.
-8-4 locomotives with cast-steel beds for South-ica. (3 600 words & fig.)

1950 **621** .33
Engineering, March 24, p. 319; March 31, p. 347; April 7, p. 390.
Convention on electric railway traction. (10 000 words.)

1950 **621** .33
Engineering, March 31, p. 365.
KITCHIN (F. B.) & HOLLAND (J.). — **Railway electrification :** Design of overhead equipment. (3 000 words & fig.)

1950 **621** .33 (68)
Engineering, April 7, p. 396; April 14, p. 427.
The 3000-volt mercury-arc rectifier traction sub-stations of the South-African Railways. (5 800 words & fig.)

1950 **621** .335 & **621** .431 .72
Engineering, April 14, p. 423.
COX (E. S.). — **Mechanical design of electric and Diesel-electric locomotives.** (5 000 words & fig.)

1950 **625** .143 .2
Engineering, May 26, p. 585.
BANKS (Luen B.). — **Machine for testing rails in bending fatigue.** (2 500 words & fig.)

1950 **621** .333
Engineering, June 9, p. 663.
FLETCHER (G. H.) & BINNEY (E. A.). — **Modern electric traction motors and gearing.** (6 000 words & fig.)

1950 **621** .431 .72 (42)
Engineering, April 23, p. 699.
500 HP Diesel-mechanical locomotive. (600 words & fig.)

1950 **621** .132 .6 (460)
Engineering, June 30, p. 725.
0-8-0 Tank locomotive for Spain. (700 words & fig.)

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1950 **62** (01 & **624** (0
Journal, Institution of Civil Engineers, January, p. 198.
SHU-TAO-CHEN. — Cable stresses on suspension bridges. (2 000 words & fig.)

Journal, The Permanent Way Institution. (London.)

1950 **624** .61 (42)
Journal, The Permanent Way Institution, December, p. 186.
GEORGE (G. F.). — **Restoration of the up-line after collapse** of part of Shepton Mallet Viaduct. (1 200 words & fig.)

1950 **625** .142
Journal, The Permanent Way Institution, December, p. 193.
ROBINSON (N. S.). — **Sleepers.** (1 400 words.)

1950 **625** .17
Journal, The Permanent Way Institution, December, p. 197.
WILSON (J.). — **Discharging and relaying** with 60-ft. B. H. rails and pre-stressed Dow-Mac concrete sleepers by hand. (800 words.)

Railway Age. (New York.)

1950 **625** .174 (73)
Railway Age, January 14, p. 26.
Burlington introduces electric snow plow. (900 words & fig.)

1950 **625** .24 (73)
Railway Age, January 28, p. 27; February 4, p. 38.
WYER (W.). — **Freight cars-** repair, rebuild or buy new (Parts I and II). (6 000 words, tables & fig.)

1950 **656** .254 (73)
Railway Age, February 11, p. 36.
Train movements by signal indication on the Clinchfield (1 500 words & fig.)

1950 **625** .234 (73)
Railway Age, February 25, p. 48.
GHAI (M. L.). — **Principles of radiant heating for comfort in passenger cars.** (2 700 words & fig.)

1950 **625** .174 (73)
Railway Age, March 4, p. 44.
1500 HP rotary snow plows. (1 500 words & fig.)

1950 **625** .143 .3 (73)
Railway Age, March 4, p. 55.
DRAKE (H. C.). — **Sound testing searches out rail defects within limits of joint bars.** (1 600 words & fig.)

1950 **625** .232 (73)
Railway Age, March 18, p. 52.
Aluminium sleeping cars for three roads. (2 000 words & fig.)

1950 **62** (01
Railway Age, March 25, p. 32.
COUGHLAN (R. E.). — **The testing of railway materials.** (1 200 words & fig.)

1950 **621** .335 (73)
Railway Age, March 25, p. 35.
MONTEITH (A. C.). — **Rectifier-type locomotives now being built for the Pennsylvania.** (1 800 words & fig.)

1950 **625** .174 (73)
Railway Age, April 8, p. 36.
Rotary snow plow of unique design. (1 200 words & fig.)

1950 **621** .438 (7
Railway Age, April 15, p. 59.
YELLOTT (J. I.). — **The experimental coal-burnin gas turbine.** (4 000 words & fig.)

1950 **621** .431 .72 (7
Railway Age, April 22, p. 52.
BLEIBTREU (H.). — **Economics of Diesel electr multiple-unit trains.** (3 600 words & fig.)

1950 **625** .142 .2 (7
Railway Age, April 22, p. 59.
MILES BURPEE (C.). — **Six years of vapor-dri ties.** (200 words & fig.)

1950 **621** .431 .72 (7
Railway Age, April 29, p. 42.
Fairbanks-morse introduces versatile « Consolidati Line » Diesel locomotives. (2 600 words & fig.)

1950 **624** .8 (7
Railway Age, April 29, p. 48.
Southern completes large lift bridge. (2 300 wor & fig.)

1950 **625** .243 (7
Railway Age, May 13, p. 48.
Six advanced features built in one car. (1 100 wor & fig.)

1950 **625** .24 (7
Railway Age, May 20, p. 167.
Progress in freight car design and maintenance. (2 2 words & fig.)

1950 **625** .144 .4 (7
Railway Age, May 20, p. 192.
Big track machines combat high costs. (800 wor & fig.)

In Danish (= 439.81).

Sikringsteknikeren. (Copenhagen.)

1950 **656** .25 (09 (42) = 439.
Sikringsteknikeren, No. 1 and 2, p. 427.
FORCHAMMER (N.). — Some **problems of sign ling** as they were in England in 1874. (7 500 wo & fig.)

In Spanish.

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1949 **385** (
Boletin de la Asoc. perman. del Congreso Panam de Ferrocarriles, septembre-octubre, p. 20.
CARIOLA (J.). — **Organización de los Ferrocarr del Estado de Chile.** (10 000 palabras.)

1949 **385** (09 (82)
)letin de la Asoc. perman. del Congreso Panamericc. de Ferrocarriles, septembre-octubre, p. 48.
REBUELTO (E.). — Algunas caracteristicas de los **rrocarriles argentinos.** (20 000 palabras.)

1950 **385** (06 .16
)letin de la Asoc. perman. del Congreso Panamericc. de Ferrocarriles, julio-agosto, p. 33.
VII Congreso Panamericano de Ferrocarriles. Su orgaзación. (10 000 palabras.)

1950 **621** .431 .72 (460)
)letin de la Asoc. perman. del Congreso Panamericc. de Ferrocarriles, julio-agosto, p. 83.
El Tren « Talgo ». Caracteristicas generales. (4 000 labras & fig.)

Ferrocarriles y Tranvias. (Madrid.)

1950 **385** (07 .2 (460)
errocarriles y Tranvias, julio, p. 265.
MENDIZABAL (D.). — El **laboratorio de investiciones ferroviarias** de la Escuela de Caminos (L. I. F.). 500 palabras.)

1950 **621** .431 .72 (43)
errocarriles y Tranvias, agosto, p. 316; septiembre, p. 357.
LAMPE (K.). — **Nuevas tendencias de la tracción iesel** en Alemania. (14 000 palabras & fig.)

In Italian.

Giornale del Genio Civile. (Roma.)

1950 **624** .63
iornale del Genio Civile, gennaio, p. 12.
RINALDI (G.). — Osservazioni sulla documentazione erimentale di un **arco in calcestruzzo di cemento esnsivo.** (1 600 parole & fig.)

1950 **624** .2
iornale del Genio Civile, febbraio, p. 79.
BELLUZZI (O.). — Contributo allo studio delle **travi ricate di punta.** (2 000 parole & fig.)

1950 **691**
iornale del Genio Civile, marzo, p. 131.
MORANDI (R.). — Dispositivo per la realizzazione **strutture di cemento armato precompresso.** (2 000 role & fig.)

1950 **691**
iornale del Genio Civile, marzo, p. 136.
RINALDI (G.). — Il problema degli **ancoraggi rminali dei cavi nelle strutture in cemento armato ecompresso.** (3 000 parole & fig.)

1950 **691**
Giornale del Genio Civile, marzo, p. 141.
CAMIZ (V.). — Formule semplificate per il calcolo senza tabelle delle **sezioni rettangolari inflesse di cemento armato.** (1 500 parole.)

1950 **624** .63 (45)
Giornale del Genio Civile, aprile, p. 210.
RINALDI (G.). — **Ricostruzione del ponte** del Samoggia in **cemento armato precompresso.** (1 000 parole & fig.)

Ingegneria ferroviaria. (Roma.)

1950 **621** .133 .7
Ingegneria ferroviaria, luglio-agosto, p. 441.
GUZZANTI (C.). — **Locomotive moderne e preriscaldatori a fumo.** (5 000 parole, tavole & fig.)

1950 **656** .251
Ingegneria ferroviaria, luglio-agusto, p. 451.
RIGHI (R.). — **Questioni di visibilità e di colore** nel segnalamento ferroviario. (7 000 parole & fig.)

1950 **656** .2
Ingegneria ferroviaria, luglio-agosto, p. 475.
MACCHIAROLI (G.). — **L'organizzazione scientifica** delle aziende di trasporto. (5 000 parole & fig.)

1950 **385** .57
Ingegneria ferroviaria, luglio-agosto, p. 485.
BOGANELLI (E.). — **Selezione psicofisiologica** degli operai meccanici. (4 000 parole, tavole & fig.)

1950 **621** .135 .4 & **625** .215
Ingegneria ferroviaria, settembre, p. 535.
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